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FORAGERS AND COLLECTORS IN THE ARCHAIC AND WOODLAND PERIODS:
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Abstract

The archaeological record in northeastern Oklahoma has been infrequently plumbed for evidence regarding the timing and pace of the hunter-gatherer change from mostly "Forager" strategies to mostly "Collector" behavior. The best current evidence suggests that by 1,000 C.E. the populations of the region had adopted sedentary farming as a major subsistence regime. However intriguing indirect evidence of changes in hunting practices, complex subsistence strategies, and increasing sedentism has been noted for populations in the vicinity of Lake Hudson, in Mayes County. Analysis of stone projectile points has the potential to increase the resolution of our understanding of incipient residential sedentism in the region. Contemporaneous Archaic and Woodland components from four sites in the vicinity of Lake Hudson contain a projectile point assemblage ranging from the Early Archaic to the Terminal Late Woodland. In this thesis research I evaluate the extent to which these projectile points exhibit criteria associated with a shift from highly residentially mobile forager hunting and gathering subsistence to a more sedentary collector logistical strategy.

A research sample of Archaic and Woodland Period projectile points from these four sites was analyzed using morphological metrics analyses. The results of these analyses were statistically examined in search of correlations indicating of a shift in technological organization matching the increasing adoption of more sedentary Collector subsistence activity during the period in question. This research concluded that the lithic analysis produced inconclusive results that did not match the manufacturing and curation expectations set forth in the Forager-Collector subsistence and land-use model.

Chapter 1: Introduction

A gradual evolution in hunting technology and residential mobility took place in northeastern Oklahoma between about 4,000 BCE and 1,000 CE. The inhabitants of the Grand River drainage and neighboring areas began making and using a greater variety of stone projectile-points than during previous millennia and by the terminal Late Woodland they were living in sedentary settled villages. Side-notched, corner-notched, and basal-notched points had tipped the spears of hunters and warriors in the region for most of the Archaic period (6,000 BCE – 1 BCE) in Oklahoma. Then, for reasons that are not yet fully understood, a new variety of stemmed projectile-points appeared in terminal Late Archaic and early Woodland hunting toolkits just as regional inhabitants may have been embracing a shift toward residential sedentism. These newer stemmed points surged in prevalence alongside the then-common notched spear point types in regional hunting technology. This technological change was accompanied by the eventual end of residentially mobile foraging lifeways and a transition to increasingly sedentary collector subsistence practices during the first millennia CE. My research addresses this transition through the interpretation of lithic hunting technology.

This research examined the area of northeastern Oklahoma encompassing present-day Lake Hudson, within the Grand River drainage system, with a focus on the Archaic through Woodland periods (6,000 BCE to 1,300 CE). I ask: How and when did the inhabitants of the Lake Hudson vicinity of the Grand River shift from a forager strategy to a collector strategy? Was this shift gradual or did it proceed rapidly? How can these questions be answered through examination of lithic hunting technology? I chose to focus on these questions because of the availability of a robust amount of published archaeological research from northeastern Oklahoma coupled with a large Archaic and Woodland age assemblage of 522 spear points collected from four sites at Lake Hudson. These sources provided useful context and comparative data to bolster interpretations.

Research by Don Wyckoff, regarding the Archaic and Woodland peoples of the Grand River and adjacent Neosho River drainages, suggests that bands of hunter-gatherers may have moved between local resource areas in an increasingly sedentary and less residentially-mobile way trending from the Middle Archaic onward (Sabo et al. 1990; Wyckoff 1984:145, 150). Archaeologists have concluded that these Archaic people relied on the use of spear-throwers, or atlatls, for hunting local fauna, and this technology persisted into the later Woodland Period (Vehik 1984; Wyckoff 1984:134). The transitional Late Archaic and Woodland Period in eastern Oklahoma is not archaeologically understood with the clarity of later eras, and the appearance of differing projectile-point types in the archaeological record is often relied on as a sort of dividing lines between cultural periods. Thus, evidence regarding the introduction of new point types, designs, and manufacturing processes over the preceding 4,000 to 6,000 years can contribute to a more complete picture of the subsistence strategies, mobility, and settlement tendencies of local pre-contact peoples. Enhancing that picture is the objective of this thesis.

Observable evidence regarding this shift has been illuminated by employing a foraging and collecting subsistence theoretical matrix designed for projectile point interpretation. The framework for this theoretical matrix is based on the Forager/Collector land use spectrum first advocated by Lewis Binford (1980). Binford's spectrum characterizes land use, residential occupation variation and subsistence strategies - primarily among hunter-gatherers - into a continuum ranging from foragers to collectors. Several researchers have proposed observable correlations between lithic technologies and Binford's Forager/Collector spectrum (Bleed 1986; Bousman 1994; Kuhn 1989; Nelson 1991). A number of these testable correlations were operationalized by Bonnie Pitblado (2003) into a Foraging Systems/Collecting Systems Land-Use Model. I have adapted eleven observable technological variables from Bonnie Pitblado's model for use in interpreting the changing subsistence and sedentism status of the inhabitants of the Lake Hudson vicinity during the Archaic and Woodland Periods (Tables 1, 2, & 3). These recorded variables directly reflect the manufacturing and curation expectations set forth within the model.

Six cultural periods form the smaller chronological divisions within these two overarching periods. The earliest dated spear points in this study originated with the Early Archaic/Grove A Focus and proceed chronologically forward through to the Late Woodland/Delaware B Focus (Baerreis 1951, Purrington 1971, Sabo, et al 1990, Wyckoff 1984). Each of these chronological divisions denotes a set date range in northeastern Oklahoma, and each exhibits a specific list of associated spear point types (i.e. the Late Woodland/Delaware B types include Gary, Langtry, Snyders/Cooper, Marshall, Marcos, Williams, Cupp, etc). A thorough macroscopic analysis of these spear points was conducted. Using the Early Archaic/Grove A Focus points' metric data as the baseline for comparison, the dataset for each of the five subsequent cultural periods was compared with the data from each immediately preceding period to determine if a statistical change is present. This method is intended to uncover changing technological design, manufacture and usage trends that inform on the relative degree of forager or collector activities.

The primary assumption based on the present understanding of culture history for the region was that artifacts from the Early Archaic would exhibit traits consistent with a foraging system, and that an observable gradation would be visible in the data from each subsequent cultural chronological phase leading to strong correlations for collector behavior by the latter

Woodland Period. The shift from foragers to collectors should present observable changes to projectile point design, manufacture, curation, and reliability according to the authors included in the Foraging Systems/Collecting Systems Land-Use Model (Table 2). For example, changes to point manufacture involving increased incidents of heat treatment are interpreted as evidence of increased energy investment, and thus they may represent a "Resource Maximized" collector group strategy. My anticipated lithic change postulates are listed in Table 1, and source citations are located in Chapter 2, Table 2.

Table 1. Testable Lithic Change Postulates.

Postulates
A greater degree of Maintainable weapons will be indicated by lighter, smaller spear points, while a greater degree of Reliable weapons will be indicated by a change toward heavier, bigger spear points.
A greater degree of Maintainable weapons will be indicated by changes toward spear points reworked in the haft, while a greater degree of Reliable weapons will be indicated by discarded, unrepaired spear points.
A greater degree of Time Minimized weapons will be indicated by changes toward spear points made more from informal flake blank technology using less overall energy investment, while a greater degree of resource maximized weapons will be indicated by greater percentage of formal biface blank technology and using greater overall energy investment.
A greater degree of make-and-mend weapons will be indicated by changes toward spear points repaired expediently in the haft and a lower percentage of unrepaired incomplete spear points, while a greater degree of "Gearing-Up" weapons will be indicated by greater percentage of unrepaired damaged spear points and less reworking.
A greater degree of forager tools used to exhaustion will be indicated by changes toward extensively reworked spear points, while a greater degree of collector-style tools replaced before exhaustion will be indicated by less reworking.
A greater degree of forager tools used to exhaustion will be indicated by changes toward high stem-to-length ratio, while a greater degree of collector-style tools replaced before exhaustion will be indicated by low stem-to-length ratio.
Forager-style spear points will exhibit less attention paid to hafting, while collector style tools will exhibit greater attention to hafting.

The second chapter of this paper discusses the theoretical approaches I have used to guide my analysis and that I have applied to formulate my interpretations. The third chapter provides a background of northeastern Oklahoma and the Lake Hudson study area beginning with a discussion of the environmental setting during the Archaic and Woodland periods, and the modern era setting. I then provide a culture history for the vicinity of Northeast Oklahoma during the Archaic and Woodland periods. I complete Chapter three with a summary of previous archaeological research and fieldwork conducted in the Lake Hudson vicinity and a description of the four Yost Collection sites and also 13 of the most well researched hunter-gatherer sites in that region. Chapter four presents a typology and discussion of the projectile-point study sample, and the fifth chapter details the methodology and techniques used to analyze the research sample. I then present the results of my analysis and discuss my interpretations of the data in the sixth and seventh chapters. The final chapter reports my conclusions and recommendations.

Chapter 2: Theory

While the first objective of my research is to measure the ways in which hunting technology changed during the Archaic and Woodland Periods at Lake Hudson, my second goal is to interpret those changes and attempt to produce explanations for why particular subsistence strategies were utilized. I seek to understand the timing and degree of changing behavior displayed along the forager-collector spectrum over time by examining changes in spear points. A number of theoretical approaches may yield compelling results in this task, but I have chosen to use a combined interpretive strategy that was employed effectively by Bonnie Pitblado in her analysis of Paleoindian projectile-points in the Rocky Mountains (Pitblado 2003). This model, by which the Lake Hudson spear points were evaluated, relies on Lewis Binford's forager-collector land-use spectrum as its foundation.

Binford's spectrum supports the idea that residentially mobile hunter-gatherers – which he termed foragers – could be differentiated from logistically mobile groups – collectors – based on the greater frequency of residential base camp moves of the former in comparison with the latter (Binford 1978b, 1980**)**. In this system, Foragers move across the landscape between "patches" of resources, while Collectors establish longer-lasting base camps and send out logistical parties to gather resources and return them to the main group (Binford 1980). Binford described the differences succinctly, stating "Foragers move consumers to goods with frequent residential moves, while collectors move goods to consumers with generally fewer residential moves" (Binford 1980). These systems should be observable in the archaeological record because differing degrees of mobility impose differing observable requirements upon technological systems. These differing modes of mobility are in turn dictated by factors such as proximity and availability of critical resources (i.e. water, large fauna, tool stone, seasonally abundant high-value food sources). Binford (1980) was careful to note that forager or collector strategies are not discrete, but are part of a spectrum, and can be combined and separated based on environmental structure and changes. Additionally, there are varying degrees of residential and logistical mobility within each strategy (i.e. forager-focused groups may undertake more or fewer residential moves in a given time frame (Binford 1980). Within this theoretical approach one would expect residential bases to contain the bulk of recoverable artifacts, while logistical camps would also exhibit sizable – though specialized – assemblages as well. Foraging locations outside the forager residential base would be expected to contain very limited numbers of artifacts or possibly none (Binford 1980:9).

Pitblado's interpretive framework builds upon the forager-collector continuum foundation by cross-referencing the related suppositions put forth by Bleed (1986), Kuhn (1989), Nelson (1991), Bousman (1994), and others in their efforts to demonstrate the effects of degrees of residential versus logistical mobility on projectile points and other lithic artifacts (Pitblado 2003:49-51). Pitblado's Foraging Systems/Collecting Systems Land-Use Model demonstrates that artifact data trends can be tested using this combined interpretive matrix to produce inferences regarding technological adaptations and subsistence strategy (Pitblado 2003). I have relied on an adapted and abridged version of this inferential framework in my study of the Yost Collection projectile-points from Lake Hudson (Table 1).

Table 2. Theoretical Correlates Between Subsistence Land-Use and Lithic Hunting Technology (Adapted from Pitblado 2003, Table 3.3).

Subsistence Strategy:	**Forager System**	**Collector System**
Land-Use Strategy:	Residentially Mobile	Logistically Mobile
Lithic Hunting Technology Principles and Observable traits:	Weapons Maintainable (Bleed 1986): Lighter-Smaller, Reworked in Haft	Weapons Reliable (Bleed 1986): Heavier-Bigger, Discarded and Not Repaired
	Time Minimization (Bousman 1994): Less Energy Investment, Informal Flake Blank Technology	Resource Maximization (Bousman 1994): Greater Energy Investment, Formal Biface Blank Technology
	"Make and Mend" (Bousman 1994): Expedient Repair; Fewer Broken Points	"Gearing Up" (Binford 1980; Bousman 1994): Less Reworking; More Broken Points
	Tools Used to Exhaustion (Kuhn 1989): Extensive Reworking; Smaller Size; High Stem-to-Length Ratio	Tools Replaced Before Exhausted (Kuhn 1989): Less Reworking; Larger Size; Low Stem-to-Length Ratio
	Less Attention to Hafting (Nelson 1991): Less Standardization	More Attention to Hafting (Nelson 1991): Standardization

Within this interpretive framework are five forager/collector technology principals that are my focus: Maintainability versus Reliability (Bleed 1986), “Make and Mend” versus “Gearing Up” (Bousman 1994), Tools Exhausted versus Tools Not Exhausted (Kuhn 1989), Less Energy Investment versus Greater Energy Investment (Bousman 1994), and Less Attention to Hafting versus More Attention to Hafting (Nelson 1991).

Reliable systems (Bleed 1986) are complex in design and method of manufacture, and require skilled, specialist craftspeople to produce and maintain them. Bleed describes these forager-style systems as “overdesigned”, with the consequence that these artifacts are capable of performing several different tasks well when in use, though they would then require specialist maintenance after use (Bleed 1986). These systems would be used to hunt specific, predictably available game. Maintainable systems are designed to be lighter, easier to use and repair, and maintained by the non-specialist user while pursuing "game that is continually available but on an unpredictable schedule." (Bleed 1986:739).

Bousman (1994:76) proposed that foragers use a "make and mend" technological strategy that places less time investment in tool manufacture or maintenance. Alternatively, Binford (1980) suggested a collector "gear up" strategy in which tools are manufactured and maintained in preparation for specific planned activities, leading to periods of intensive time investment. This strategically increased time and energy investment in hunting tool systems differentiates those "resource maximizing" collectors from the more generalized forager tool systems. This differential investment may be observable in the rate of activities like heat-treatment of lithic material during manufacture. Characteristics like the use of informal flake blank technology are indicative of less time spent and less energy invested in manufacture. This argument was also pursued by Kuhn (1989), who proposed that collector systems would wish to avoid any failure of their tools during use by discarding damaged or flawed tools and manufacturing new, pristine tools with less chance of failure. Kuhn argues that residentially organized foragers would maintain and repair tools until they reached exhaustion (Kuhn 1989).

Finally, Nelson (1991) theorized that the reliable projectile-point designs of collectors should exhibit a high degree of haft element standardization, with very little variation in haft size and base morphology. This uniformity of design is another layer of insurance against projectile-point use-failure in hunting toolkits during the hunt. Maintainable-system foragers would not have relied on such redundancy, as their points would have been expediently repaired on site and in the haft.

My analysis examined the Yost Collection point assemblage for observable traits indicative of forager or collector design, manufacture, usage, and maintenance (Tables 1 & 2).

Table 3. Correlation between Technological Principals and Tested Variables.

Tested Variable	**Lithic Change Postulates**	**Technological Principals**
Weight	A greater degree of Maintainable weapons will be indicated by lighter, smaller spear points, while a greater degree of Reliable weapons will be indicated by a change toward heavier, bigger spear points.	Maintainable (Forager) vs. Reliable (Collector)
Complete or Incomplete	A greater degree of Maintainable weapons will be indicated by changes toward spear points reworked in the haft, while a greater degree of Reliable weapons will be indicated by discarded, unrepaired spear points.	Maintainable (Forager) vs. Reliable (Collector)
	A greater degree of make-and-mend weapons will be indicated by changes toward spear points repaired expediently in the haft and a lower percentage of unrepaired incomplete spear points, while a greater degree of "Gearing-Up" weapons will be indicated by greater percentage of unrepaired damaged spear points and less reworking.	"Make and Mend" (Forager) vs. "Gearing Up" (Collector)
Rework: Presence or Absence	A greater degree of Maintainable weapons will be indicated by changes toward spear points reworked in the haft, while a greater degree of Reliable weapons will be indicated by discarded, unrepaired spear points.	Maintainable (Forager) vs. Reliable (Collector)

	A greater degree of make-and-mend weapons will be indicated by changes toward spear points repaired expediently in the haft and a lower percentage of unrepaired incomplete spear points, while a greater degree of "Gearing-Up" weapons will be indicated by greater percentage of unrepaired damaged spear points and less reworking.	"Make and Mend" (Forager) vs. "Gearing Up" (Collector)
Rework: Presence or Absence	A greater degree of forager tools used to exhaustion will be indicated by changes toward extensively reworked spear points, while a greater degree of collector-style tools replaced before exhausted will be indicated by less reworking.	Tools used to Exhaustion (Forager) vs. Tools Replaced Before Exhausted (Collector)
Stem-to-Length Ratio	A greater degree of Maintainable weapons will be indicated by changes toward spear points reworked in the haft, while a greater degree of Reliable weapons will be indicated by discarded, unrepaired spear points.	Maintainable (Forager) vs. Reliable (Collector)
	A greater degree of forager tools used to exhaustion will be indicated by changes toward high stem-to-length ratio, while a greater degree of collector-style tools replaced before exhausted will be indicated by low stem-to-length ratio.	Tools used to Exhaustion (Forager) vs. Tools Replaced Before Exhausted (Collector)
	A greater degree of make-and-mend weapons will be indicated by changes toward spear points repaired expediently in the haft and a lower percentage of unrepaired incomplete spear points, while a greater degree of "Gearing-Up" weapons will be indicated by greater percentage of unrepaired damaged spear points and less reworking.	"Make and Mend" (Forager) vs. "Gearing Up" (Collector)
Neck Width, Haft Length, Base Width	Forager-style spear points will exhibit less attention paid to hafting, while collector style tools	Less Attention to Hafting and Less Standardization (Forager) vs. More

	will exhibit greater attention to hafting.	Attention to Hafting and More Standardization (Collector)
Maximum Thickness	A greater degree of Time Minimized weapons will be indicated by changes toward spear points made more from informal flake blank technology using less overall energy investment, while a greater degree of resource maximized weapons will be indicated by greater percentage of formal biface blank technology and using greater overall energy investment.	Time Minimization (Forager) vs. Resource Maximization (Collector)
Heat Treatment: Presence or Absence	A greater degree of Time Minimized weapons will be indicated by changes toward spear points made more from informal flake blank technology using less overall energy investment, while a greater degree of resource maximized weapons will be indicated by greater percentage of formal biface blank technology and using greater overall energy investment.	Time Minimization (Forager) vs. Resource Maximization (Collector)
Cortex: Presence or Absence	A greater degree of Time Minimized weapons will be indicated by changes toward spear points made more from informal flake blank technology using less overall energy investment, while a greater degree of resource maximized weapons will be indicated by greater percentage of formal biface blank technology and using greater overall energy investment.	Time Minimization (Forager) vs. Resource Maximization (Collector)

Chapter 3: Background

My research examined the Archaic and Woodland Periods (6,000 BCE – 1,300 CE) in the area around Lake Hudson, an artificial reservoir within the Neosho and Grand River drainages in Mayes County, Northeast Oklahoma (Figure 1). This chapter will provide information on the natural setting and cultural history of Lake Hudson during the time frame in question, and will discuss previous research into local and regional mobility and sedentism.

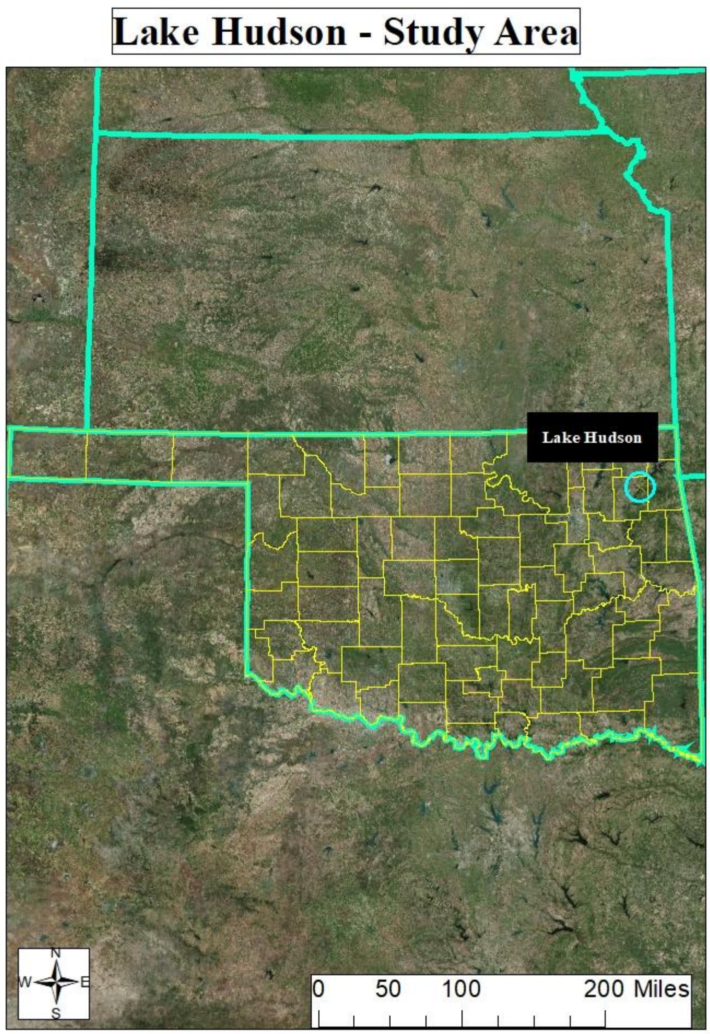

Figure 1. Lake Hudson, Mayes County, Oklahoma.

Geology and Geomorphology

The study area surrounding Lake Hudson encompasses parts of two geomorphic provinces: The western Ozark Plateau, specifically the Springfield Plateau, and the western Neosho Lowlands (K. Johnson 2006:5-9). Lake Hudson is located on the boundary between the Neosho Lowlands and the Springfield Plateau. The Springfield plateau is a gently rolling plain with less relief and better soils than any other Ozark Plateau subdivision (Sabo, Early, Rose, Burnett, Vogele, and Harcourt 1990). The greater Ozark Plateau consists primarily of Mississippian marine limestone and chert, which are heavily dissected around the plateau. Marine shale and sandstone are present in lower percentages. Elevations across the plateau range from approximately 198 to 500 m above sea level (asl). The Neosho Lowlands contain the Neosho and Grand River drainages. These areas are gently rolling, low-relief vales consisting of Pennsylvanian sandstone and limestone (K. Johnson 2006:5-9). Terraced landforms are common around Lake Hudson in locations where tributary streams flow into the Grand River.

Figure 2. Lake Hudson, Mayes County, Oklahoma.

Figure 3. Robert S. Ker Dam, Lake Hudson, Mayes County, Oklahoma.

Climate History

During the modern era, the dominant vegetation throughout the study area is Oak-hickory and Oak-pine forest with minor Post oak and blackjack forest habitats in lower elevations (Albert and Wyckoff 1984:4). However, climate conditions within the study area during the early and middle Archaic periods were considerably drier and warmer, giving rise to a savanna-like grassland habitat in the study area (Wyckoff 1984:135). This climatic period, from about 6,500 BCE to 3,000 BCE – also known as the Altithermal, Hypsithermal, or Holocene Climatic Optimum – was a period of dry prairie-friendly conditions that eventually shifted toward a wetter, cooler climate after 3,000 BCE (Vehik 2001:148). Prairie vegetation spread eastward during this dryer period, expanding the range of prairie wildlife species into northeastern Oklahoma (Sabo, et al 1990). Vegetation in northeastern Oklahoma probably reached its modern variety and distribution after the Altithermal sometime between 3,000 BCE and 300 CE (Albert 1981: Figures 26, 27, and 31).

Faunal Resources

Prehistoric hunters enjoyed access to numerous faunal resources in northeastern Oklahoma from the Archaic Period to the present. Consistently available species included white-tailed deer, elk, turkey, raccoon, shellfish, turtles, beaver, squirrel, spotted skunk, coyote, gopher, various fowl and fish, and various small rodents and reptiles (Wyckoff 1984:119, 138, 149). Bison, which were seasonally available during pre-Archaic times, also re-occupied the study area in increasing numbers after the Altithermal and persisted from about 3000 BCE until the late nineteenth century CE (Wyckoff 1984:144)

Floral Resources

Gatherers and foragers in northeastern Oklahoma during the Archaic and Woodland had seasonal access to nuts, seeds and berries, but evidence of specific species is lacking (Wyckoff 1984:138). Additional seeds and plant parts recovered from Woodland Period sites include smartweed, bedstraw, spurge, pear, mustard, grape, blackberry, and yellow woodsorrel. Several potential cultivars that were regionally available to inhabitants included squash, gourd and *Chenopodium/Amaranthus.* Initial occurrences of marshelder and maize appear during the Woodland Period (Brooks 2012: 36-37).

Lithic Resources

There is a wide variety of locally and regionally abundant knappable stone resources. Jack Ray (2007) defines local resources as raw materials available within approximately 6 kilometers (km) of a site. Ray notes that locally available resources form the majority of chipped-stone assemblages in the Ozarks (Ray 2007). The primary local lithic resources available within the study area are the Boone group cherts, which include a heavy concentration of the Keokuk, Burlington, and Reed Spring formations occurring on the Ozark Plateau (Banks 1984:79, 200). Boone chert is widely available throughout the study area in the form of creek bed cobbles and bedrock exposures (Wyckoff 1984:129). Boone is a high-quality, fine-grained lithic material that was intensively utilized by prehistoric inhabitants of the region across all time periods (Banks 1984:83).

Other available lithic resources in the Ozarks included Morrison, Peoria, Sallisaw and St. Joseph cherts, Cotter Dolomite, and rhyolite (Bob Brooks, personal communication 2018; Banks 1990). Resources available beyond the local range of 6 km included Argillite siltstone, Moorefield, cherts from the Boston Mountains to the south, and Florence and Kay County Cherts to the northwest (Brooks, personal communication 2018; Ray 2007).

Arkansas Novaculite was also available to prehistoric toolmakers in northeastern Oklahoma; however, the ease of access to abundant local Boone group chert made this source the most utilized lithic material in the Yost Collection spear point assemblage.

Culture History: The Archaic Period in the Western Ozarks c. 6,000 BCE – 1 BCE

The Archaic Period Ozarks in northeastern Oklahoma and northwestern Arkansas was a time of diversifying cultural complexes and marked proliferation of projectile point types (Sabo et al 1990). The cultural chronology during this period has been successively refined by Baerreis (1951), Purrington (1971), Wyckoff (1984) and Sabo, et al (1990) among others. David Baerreis divided the Archaic in northeastern Oklahoma into three successive periods of cultural development labeled the Grove A, Grove B, and Grove C foci based on evidence of increasing residential sedentism through time (Barreis 1951). Barreis' interpretations were based on his excavations of preceramic sites along the Grand River in Delaware County, adjacent to Mayes County (Sabo et al, 1990). The Early Archaic (6,000 - 4,000 BCE) and the Grove A focus are approximately analogous.

Early Archaic/Grove A inhabitants in the region were residentially mobile hunters and gatherers who moved between open campsites, caves, and rockshelters in the Ozarks. Larson (1997) has proposed that these groups were the first in the region to utilize a "tethered nomadism" settlement pattern – a term created by Taylor (1964) and Binford (1980) – in which small groups established residential base camps that moved seasonally. This new form of foraging relied on procurement task teams being sent out to hunt or gather specific resources, establishing briefly occupied processing field camps (Larson 1997; Latham 2007). They relied heavily on very high quality Ozark cherts for their projectile points, hide scrapers, and other lithic tools. They used spear throwers and notched points in their hunting toolkit. Regional specialist Don Wyckoff has noted that these assemblages share similarities with early Holocene Plains bison-hunting cultures, though direct evidence of bison hunting is lacking (Wyckoff 1984:134). Evidence for probable late Paleoindian Period and Early Archaic Period residential campsites in the region of modern Lake Hudson predominantly comes from the Packard site (34MY66) in Mayes County.

The region was more widely inhabited by hunting and gathering people by the Middle Archaic/Grove B Focus (4,000 – 2,000 BCE), and both rockshelter and open habitation sites were in use by that time (Wyckoff 1984:145). This period saw the gradual ending of the grassland-friendly Altithermal and the slow westward expansion of woodland floral and faunal systems through northeastern Oklahoma. Common elements of Middle Archaic/Grove B material culture included notched, unfluted spear-points, basketry, and the introduction of ground stone technology such as manos and metates. Heavier and less portable artifacts and smaller foraging ranges led to decreasing overall mobility and increased occupational repetition of select sites. These processes led to larger base campsites with more intensive and eventually permanent occupations. Archaeological evidence for this shift to greater residential sedentism includes a wider diversity of artifacts/activities at occupation sites, including extensive midden features (Sabo et al 1990). Foraging efforts were intensified and diversified. Generalized hunting and foraging took place in small logistical groups and became limited to bottomland biotic communities (Sabo et al 1990).

Wyckoff has taken the broad Grove B northeastern Oklahoma cultural concept and refined it into distinctive assemblages based on diagnostic spear-point styles. The Tom's Brook Complex (4,000 – 3,000 BCE) was named after a contemporaneous stratified rockshelter site in northwestern Arkansas (Sabo et al 1990). Wyckoff notes that artifacts representing the Tom's Brook Complex are observable at several sites in the Lake Hudson region (Wyckoff 1984:136-140). These sites include Dawson (34MY10), Pohly Shelter (34MY54), Jug Hill (34MY18), Packard (34MY66), McConkey (34DL21), Cooper Shelter (34DL48), and Smith I Shelter (34DL55). Approximately 16 notched projectile point types define the Tom's Brook Complex as described by Wyckoff (1984); these include the research sample types Uvalde, Frio, Williams, Marcos, and possibly Ensor and Edgewood types, often considered Late Archaic in origin. All of these types are present within the Yost Collection assemblage (Wyckoff 1984:136). Tom's Brook Complex sites' inhabitants appear to have been less residentially mobile than Early Archaic groups, using open habitation sites and rockshelters for longer stretches of time while exploiting local resources, possibly through logistical forays (Wyckoff 1984:138-139). These groups continued to rely on Ozark cherts for lithic tool purposes; they emphasized heat-treatment for a greater degree of manufacturing craftsmanship (Neal and Benefield 2001; Wyckoff 1984:138). These predominantly locally oriented people may have had limited cultural contact with central Texas Archaic groups (Wyckoff 1984:139).

Wyckoff (1984:140) defines the latter half of the Grove B Focus as the Caudill Complex (3,000 – 2,000 BCE). This is the millennium immediately following the close of the Altithermal. Sites in the study area containing Caudill Complex components include Caudill (34DL59), Cooper Shelter (34DL48), McConkey (34DL21), Smith I Shelter (34DL55), Wolf Creek (34MY72), Pohly Shelter (34MY54), and Evans (34DL38). The complex consists of both rockshelter and open habitation sites similar to the Tom's Brook Complex. However, Caudill Complex sites exhibit less evidence of extended habitation and may have been specialized deer-hunting camps with some seasonal nut, berry, and seed collecting (Wyckoff 1984:140-141). Faunal remains at Caudill sites indicates that deer was the primary prey, while turkey, skunk and raccoon were also hunted (Wyckoff 1984:141). Common Caudill Complex projectile-points types include Smith, Marshall, Williams, and also Marcos spear points, the latter of which are often considered Late Archaic in origin. Six other similarly large spear point types common to the Ozarks are also represented, however none of those types are included in the Yost Collection assemblage (Wyckoff 1984:141). Evidence of an increase in burned-rock fire pits, storage pits, stone grinding basins, and structural remains such as post-molds suggests steadily decreasing mobility and increasing residential sedentism during the transition from the Middle Archaic (c. 4,000 - 2,000 BCE) into the Late Archaic (c. 2,000 - 1 BCE) period (Brooks 2012; Wyckoff 1984).

The Late Archaic Period/Grove C Focus (2,000 BCE – 1 BCE) sites of northeastern Oklahoma also exhibit a marked increase in site density and thick artifact deposition, possibly further indicating instances of continuous residential occupation (Wyckoff 1984:146). This time of post-Althithermal climate coincided with a population boom across the Midwest and Southeast (Latham 2007; McGrath et al. 1998; O'Brien 1996). Semi-sedentary patterns are observable throughout the Ozarks and southeastern Oklahoma from this period forward – including the Wister phase and the later Fourche Maline phase – and exemplified by base camp sites occupied for the majority of the year accompanied by intensive local resource exploitation and seasonal logistical foraging (Sabo et al 1990). These neighboring cultural manifestations exhibited pottery, weaving, stone carving and ceremonial architecture interpreted as demonstrating sedentary village life during the Late Archaic and transitioning into the Woodland Period (Galm 1984; Leith 2011). Wyckoff identified multiple similarly composed archaeological assemblages centered on the Verdigris and Grand River drainages and expanding into western Arkansas and southwest Missouri, which he has termed the Lawrence Phase (c. 1,400 BCE – 700 BCE) (Wyckoff 1984:146-147; Neal and Benefield 2001; Latham 2007). Lawrence Phase cultures are probable descendants of the previous Caudill complex and are typically differentiated from Caudill by the introduction of Frio, Afton, Ellis, Morhiss, Table Rock Stemmed, Palmillas, and possibly Marcos projectile-point types, to the already common Marshall and Williams types in the vicinity (Wyckoff 1984:147). Lawrence Phase groups relied on local faunal and floral resources in the Grand and Verdigris lowlands, primarily deer; upland species like bison or pronghorn are absent from these assemblages (Wyckoff 1984:149-150). This may indicate increasing intensity of local subsistence resource gathering.

Culture History: The Woodland Period in the Western Ozarks c.1 CE – 1,300 CE

The Woodland Period in northeastern Oklahoma began with the Delaware A Focus (1 CE – c. 900 CE), which is regarded as a gradual progression from the preceding Grove C Focus (Vehik 1984:178). Cultural characteristics commonly used to define the advent of the Woodland Period include ceremonial architecture, horticulture, storage features, and the appearance of ceramics; however, ceramics are not uncommon in Archaic sites in northeastern Oklahoma (Latham 2007; Logan and Beck 1995). Susan Vehik identifies the introduction of Gary and Langtry contracting-stem projectile-points to the area at about 1 CE as a primary marker in differentiating the Woodland/Delaware A focus from the preceding Late Archaic/Grove C focus (Vehik 1984:178). Contemporaneous Plains Woodland sites in Kansas and north-central Oklahoma are generally located near major streams or tributaries and often have produced evidence of house foundations (Wood, et al 1998). Purrington (1970) and Wyckoff (1980) note that sedentary and semi-sedentary occupations along the Grand River began at least during the early Woodland Period as evidenced by the presence of site assemblages containing pottery and stone implements matching those of early semi-sedentary sites in western Missouri and southeastern Kansas. Along Fourche Maline Creek in southeastern Oklahoma evidence of sedentary or semi-sedentary occupations has been recorded dating to the terminal Late Archaic and early Woodland Periods (Wyckoff 1980).

Delaware A Focus subsistence practices continued to emphasize local bottomland resources and there is little evidence to suggest major changes in hunting technology beyond the large upsurge in contracting-stemmed point types. Vehik notes that bow and arrow technology was introduced on the Plains west of the study area during the early Plains Woodland Period, but may not have been adopted in more forested areas until the post-Woodland (Vehik 1984:176).

Gary and Langtry types are the most common Delaware A projectile-points, despite the probable introduction of bow and arrow technology to the study area during the latter half of the Delaware A Focus. These two stemmed types are often found in association with Marshall, Marcos, Williams, Cooper/Snyders and Smith-like spear points and the small Sequoya and Scallorn arrow point types – the latter two of which are present at the Yost Collection sites, but which are not included in this study of the Yost spear point assemblage - and six other point types that are not present in the assemblage (Vehik 1984:178-179). The contemporaneous Fourche Maline phase in southeastern Oklahoma has been described as a sedentary continuation of the earlier Wister phase (Galm 1984; Leith 2011).

The Early Woodland Period Delaware A Focus transitioned into the Late Woodland Delaware B Focus in much of eastern Oklahoma, however within the study area this transition was overlapped by the appearance of the Cooper Focus (Vehik 1984:179). Cooper Focus and Delaware B Focus dates are not firmly established, but distinctive Cooper/Snyders type points appeared in the study area during the late Delaware A Focus by at least c. 900 CE, and Delaware B occupations initiated shortly after 900 CE (Vehik 1984:179). There are only four sites in Oklahoma with Cooper Focus components and all are along the Neosho River and its tributary creeks (Table 2). Vehik has noted the strong resemblance between Cooper and Snyders point types (Vehik 1984:179). This may indicate a broader Cooper Focus geographic distribution at other regional sites exhibiting the Snyders type, but this interesting question is beyond the scope of this research.

The Cooper Focus may represent an extension of Kansas City and Illinois Hopewellian cultural influence, which had extended into southwest Missouri and southeastern Kansas and shared several common artifacts (Vehik 1984: 179-183). Cooper Focus sites, which are evenly divided between temporary hunting camps and potentially permanent villages, show a proclivity toward hunting and kill-processing activities (Vehik 1984:182-183). These sites present faunal remains that include upland species - including the presence of bison teeth - and exhibit little evidence for plant processing (Vehik 1984:182). Typical Cooper Focus projectile-point assemblages also include Gary, Langtry, Marshall and Williams dart points, and various smaller arrow point types (Vehik 1984:182).

Delaware B Focus sites exhibit a diversity of activities and potential functions ranging from river valley village sites and logistical hunting camps, and other hunting camps in bluff shelters. Direct evidence of hunting prey species is lacking, however contemporaneous neighboring areas, including north-central Oklahoma, were evidently focused on hunting deer and rabbit, and acquiring fish and turtle. Arrow point types such as Fresno, Young, White River Elliptical, Reed, Haskell, Scallorn and Sequoyah surged in popularity during this period and complimented the more common Gary, Langtry, Cooper/Snyders, Marshall, Marcos, Williams, and other dart point types (Vehik 1984:185). According to Vehik (1984), Delaware B Focus sites show some evidence of Caddoan influences from the south. Galm (1984) and Leith (2011) argue that the Fourche Maline culture of southeast Oklahoma was near completely sedentary, living at residential sites much or all of the year and returning to these sites consistently. Fourche Maline Caddoan influence may have played a role in the transition or conclusion of Delaware B occupations by c. 1,300 CE, signaling the incipient post-Woodland Neosho Focus (Vehik 1984:185).

Regional Settlement and Subsistence in the Archaic and Woodland Periods

As can be inferred from previous subsections, residential mobility, residential sedentism, and the spectrum of active collecting and foraging strategies employed across the Archaic and Woodland Periods was both chronologically variable and understood to varying degrees across the region. The Early Archaic/Grove A Focus (6,000 – 4,000 BCE) was a period of regionally widespread foraging subsistence with degrees of initial limited Collector behavior. Inhabitants ranged across the landscape – often focused on bison hunting – between seasonal residential camps from which they began to send out logistical forays to numerous smaller task-specific camps (i.e. hunting staging areas, butchering sites, plant gathering and processing camps) (Larson 1997; Latham 2007; Wyckoff 1984). During the Middle Archaic/Grove B Focus (4,000 – 2,000 BCE), settlement and subsistence patterns generally are understood to have shifted toward longer occupations of residential base-camps containing larger, less-portable artifacts. The contemporaneous Tom's Brook Complex of northeastern Oklahoma and northwestern Arkansas exhibited these traits. Hunting began to be increasingly focused on bottomland communities. Residential sites increasingly contained storage midden features as logistical mobility became more common (Sabo et al 1990). Overall mobility was reduced and a decrease in prototypical forager behavior was observable.

The subsequent Caudill Complex of the Middle Archaic (3,000 – 2,000 BCE) was comprised of similar residential open campsites and rockshelters, however the evidence for prolonged occupation is reduced from the Tom's Brook Complex. The overall Middle Archaic trend shows a reduction of forager behavior from the Early Archaic and on into the Late Archaic, with a sleight hiccup or plateau during the Caudil Complex. The Late Archaic Period/Grove C Focus (2,000 BCE – 1 BCE) saw further increases in site density and in-situ artifact density, which has been interpreted as evidence of increasingly long site occupations and population growth (Brooks 1984). Research on the Late Archaic has recorded increasing evidence of permanent site features and longer occupations (Brooks 2012; Wyckoff 1984). Semi-sedentary patterns are observable throughout the Ozarks and southeastern Oklahoma from this period forward – including the Wister phase and the later Fourche Maline phase – as exemplified by base camp sites occupied for the majority of the year accompanied by intensive local resource exploitation and seasonal logistical foraging (Sabo et al 1990). These neighboring cultural manifestations exhibited pottery, weaving, stone carving, and ceremonial architecture interpreted as demonstrating sedentary village life during the Late Archaic and transitioning into the Woodland Period (Galm 1984; Leith 2011). The contemporaneous Lawrence Phase (c. 1,400 BCE – 700 BCE) located in northeastern Oklahoma, southwestern Missouri, and northwestern Arkansas may have been descended from the Caudill complex, and continued the trend of local resource exploitation and logistical foraging in the region.

In terms of the established understanding of hunting practices, the Archaic Period inhabitants of the study area were initially probably residentially mobile bison-specialized hunters. It appears that this strategy was in decline beginning in the Middle Archaic in favor of a focus on local bottomland species – primarily deer. This deer-focused strategy seems to have taken center-stage by the time of the Caudill Complex, coinciding with the end of the Altithermal and the reintroduction of bison to the upland biota of modern northeastern Oklahoma. Other smaller game such as turkey and small mammals served as supplementary hunting targets. This venison-centric strategy likely persisted through the Late Archaic/Lawrence Phase as indicated by the lack of bison remains at these sites.

The Woodland Period beginning with the Delaware A Focus (1 CE – c. 900 CE) saw the advent of fully sedentary residential sites. Purrington (1970) and Wyckoff (1980) note that the presence of sedentary occupations along the Grand River began at least during the early Woodland Period. Evidence for this change includes site assemblages containing pottery and stone implements matching those of early semi-sedentary sites in western Missouri and southeastern Kansas. Along Fourche Maline Creek in southeastern Oklahoma, evidence of sedentary or semi-sedentary occupations date to the terminal Late Archaic and early Woodland Periods (O'Brien and Wood 1998; Wyckoff 1980). Delaware B Focus (900-1,300 C.E) sites exhibit a diversity of activities and potential functions, including river valley village sites and logistical hunting camps as well as hunting camps in bluff shelters. The contemporaneous Fourche Maline phase in southeastern Oklahoma has been described as a sedentary continuation of the earlier Wister phase (Galm 1984; Leith 2011).

In terms of hunting practices, The Early Woodland Delaware A Focus shows little definitive evidence for primary prey species, however aggregate assemblages indicate a continuation of focus on bottomland fauna. The Cooper Focus, which may have been a Hopewellian introduction from the north and northeast, showed evidence for hunting expansion into upland species, including some bison. Delaware B Focus sites do not show evidence of bison hunting – or much else specific prey evidence for that matter – however their aggregate assemblages seem to indicate a continued or renewed focus on riverine and bottomland fauna. In summation, the shift from forager-focused behavior to collector strategies in northeastern Oklahoma is currently understood to be a slow and gradual trend from the start of the Tom's Brook Complex through the Late Woodland Delaware B Focus by which time evidence of sedentary Collector lifeways had become abundant.

Culture History: Post-Contact Modern Land Use

During the post-contact-era, the area was home to both Osage groups and displaced Cherokees prior to the post-Civil War influx of Euro-American settlers. The landscape along the Grand and Neosho rivers and their tributaries continued to be shaped to suit agricultural purposes and to mitigate erosion. The Grand River Dam Authority (GRDA) constructed the Robert S. Kerr Dam across the Grand River between 1958 and 1964 as part of the Markham Ferry Reservoir Project. The resulting 12,000-acre body of water was renamed Lake Hudson upon its completion in 1964. The lake is managed and landscaped by the GRDA and the U.S. Corps of Engineers, and it is bordered by a large number of privately owned tracts of land.

Previous Archaeological Research

Much of the available data regarding Archaic period and Woodland period sites in northeastern Oklahoma and adjacent areas emerged during archaeological salvage projects for proposed dams and reservoirs (Brooks 2012:31-35). These initial archaeological surveys and excavations at Lake Hudson were no exception, and the artifacts and observations recorded by this research created the foundation for our current archaeological understanding of the region. The newly constructed Lake Hudson and its vicinity was a prime research target for the fledgling Oklahoma River Basin Survey (ORBS). The ORBS was formed to survey and excavate cultural remains in areas expected to be flooded due to planned construction of hydroelectric dams under the auspices of the Reservoir Salvage Act of 1960. The ORBS, led by Robert Bell of the University of Oklahoma, conducted the first surveys and excavations in the Lake Hudson vicinity in 1962. ORBS researchers recorded 48 sites in 1962 and 8 more in 1963. Don Wyckoff and colleagues conducted three additional field investigations in 1963 and 1964 (Wyckoff 1963, 1964; Wyckoff, Robison and Barr 1963).

Burton L. Purrington's dissertation (1971) provided the next notable research contribution for the Late Archaic and Woodland periods along the Grand River drainage and Lake Hudson. Purrington's dissertation included a comprehensive cultural history and summary of pre-1970 research and excavations in Delaware County, located on the Ozark Plateau immediately east of Mayes County and Lake Hudson (Purrington 1971). Purrington's research provides invaluable contemporaneous data for comparisons to my focal area from the upper Grand River drainage around modern Grand Lake and the Ozark Plateau. Archaeological fieldwork resumed at Lake Hudson in 2007 when the Federal Energy Regulatory Commission, which oversees the licensing of the Grand River Dam (GRDA) under federal regulations, required a shoreline survey around Lake Hudson. The survey was designed to document sites that may have been impacted by erosion. It covered 2800 acres of previously un-surveyed land and recorded 39 new sites (Day et al. 2008). Finally, in addition to professional surveys and excavations, local residents provided much of the site location data for Lake Hudson from the 1960s to present.

I have incorporated relevant data from 13 other Archaic and Woodland sites at Lake Hudson and neighboring counties in northeastern Oklahoma, particularly on the nearby Neosho and Verdigris River drainages and the Ozark Plateau. These regional sites have been excavated or otherwise recorded in detail and provided large assemblages, often clear and distinct stratigraphy, and robust data sets (Wyckoff 1984:121). The cultural history data from these adjacent zones provides a vital source of regional archaeological context during the time frame in question.

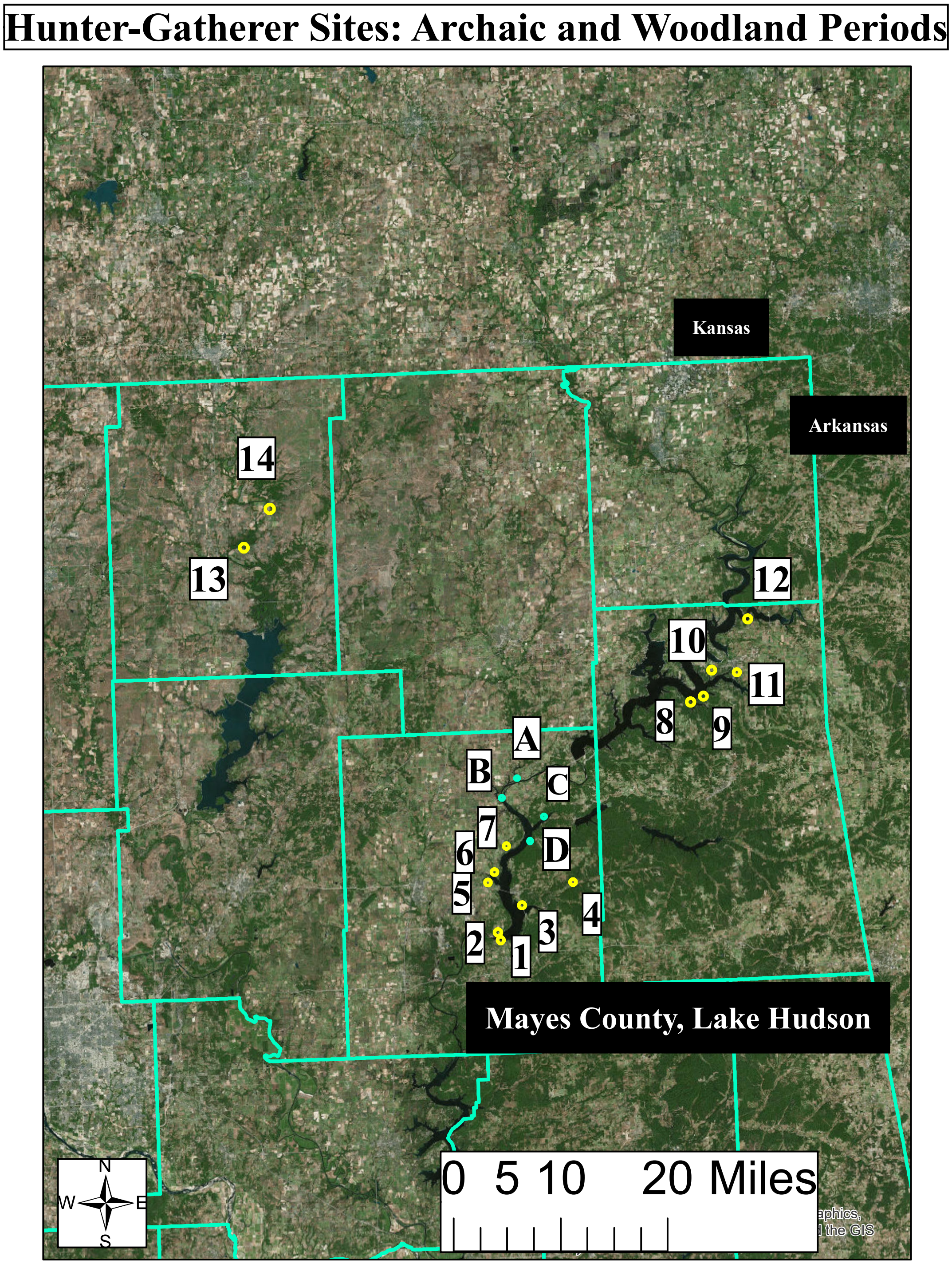

Figure 4. Map of referenced Archaic and Woodland Period sites in NE Oklahoma (See key to sites: Tables 4 and 5).

These studies have shown that local populations, during the Middle-to-Late Archaic and Woodland periods, may have gradually started to establish an increasingly sedentary residential mobility strategy in the Grand River drainage and the neighboring Neosho River drainage. Compelling evidence in this regard includes the presence of earth ovens, some evidence of structural remains and hearths, refuse-filled storage pits, and manos and metates (Brooks 2012). Less residentially mobile groups place greater reliance on logistical collection forays from the base camp to available resource locales. Storage pits and structural remains indicate at least seasonal site occupations. Table 2 describes the 13 sampled Archaic and Woodland period sites from the Lake Hudson vicinity.

Table 4. Referenced Archaic and Woodland Period sites in NE Oklahoma (Vehik 1984; Wyckoff 1984).

Fig. 4 Map Ref. #	**Site**	**Cultural Periods, Phases and Complexes of Occupation (Represented by Site Components)**	**Description**
1	Kerr Dam (34MY48)	Late Archaic (Grove C Focus/Lawrence Phase)	Open campsite with storage pits, rock hearths and evidence of earthen ovens
2	Dawson (34MY10)	Middle Archaic (Grove B Focus/Tom's Brook Complex)	Open campsite
3	Packard (34MY66)	Early Archaic (Grove A Focus/Packard Complex); Middle Archaic (Grove B Focus/Tom's Brook Complex)	Open campsite with large Ozark chert spearpoint component
4	Pohly Shelter (34MY54)	Middle Archaic (Grove B Focus/Tom's Brook Complex/Caudill Complex); Late Archaic (Grove C Focus/Lawrence Phase)	Rock shelter

5	Jug Hill (34MY18)	Middle Archaic (Grove B Focus/Tom's Brook Complex)	Open campsite
6	Wolf Creek (34MY72)	Middle Archaic (Grove Be Focus/Caudill Complex)	Open campsite
7	Shetley Shelter (34MY77)	Late Archic (Grove C Focus/Lawrence Phase)	Rock shelter
8	Smith I Shelter (34DL55)	Middle Archaic (Grove B Focus/Tom's Brook Complex/Caudill Complex); Late Archic (Grove C Focus/Lawrence Phase); Woodland (Delaware A Focus); (Delaware B Focus)	Rock shelter
9	Evans (34DL38)	Middle Archaic (Grove Be Focus/Caudill Complex)	Open campsite
10	Caudill (34DL59)	Middle Archaic (Grove B Focus/Caudill Complex); Late Archic (Grove C Focus/Lawrence Phase)	Open campsite
11	Cooper Shelter (34DL48)	Middle Archaic (Grove B Focus/Tom's Brook Complex/Caudill Complex); Late Archic (Grove C Focus/Lawrence Phase); Woodland (Delaware A Focus/Cooper Focus); (Delaware B Focus)	Open campsite with storage pits
12	McConkey (34DL21)	Middle Archaic (Grove B Focus/Tom's Brook Complex/Caudill Complex); Late Archic (Grove C Focus/Lawrence Phase)	Open campsite
13	Lawrence (34NW6)	Late Archaic (Grove C Focus/Lawrence Phase)	Open campsite with storage pits, rock hearths, possible postholes, and evidence of earthen ovens

Table 5. Yost Collection Sites at Lake Hudson.

Map Label	Site	Cultural Periods of Occupation (Represented by Site Components)	Description
A	34MY339	Woodland to Middle Mississippian	Open habitation or intermittently occupied activity site located along the Neosho River channel near its juncture with modern Lake Hudson. (Tested, 2012)
B	34MY21/320	Late Woodland/Mississippian	Open habitation or intermittently occupied activity site located near the original Neosho River channel, near its juncture with the Grand River at modern Lake Hudson. (Tested, 2012)
C	34MY318	Early Archaic to Woodland	Open habitation or intermittently occupied activity site located in pastureland on an island in Spavinaw Creek.
D	34MY362	Late Archaic/Woodland	Open habitation site located near the original Neosho River channel at modern Lake Hudson.

The Yost Collection

In addition to professionally documented sites at Lake Hudson, the Grand, Neosho, and Verdigris River drainages, and the adjacent Ozark Plateau, a local family – the Yosts - also assembled a collection of cultural materials from four locations around the lake (Brooks 2012:31-32). These locations included three sites, (34MY318, 34MY21/320, and 34MY339) recorded in 2007 (Brooks 2012:38). The fourth site, 34MY362, was recorded by Robert Brooks after the Yosts alerted him to its location in 2010 (Brooks 2012:38). The Yost Collection assemblage was recovered entirely from surface contexts and lacks stratigraphic depositional context. These sites are located around the northern end of Lake Hudson on terraces near tributary streams, and their combined surface assemblages provide an excellent representative sample of Archaic and Woodland period sites in the region (Figures 4 and 5, and Table 3). The Yost Collection consists of 3,596 total artifacts retrieved over a period of about fifty years by members of the Yost family (Brooks 2012:31-32).

Lake Hudson - Yost Collection Sites

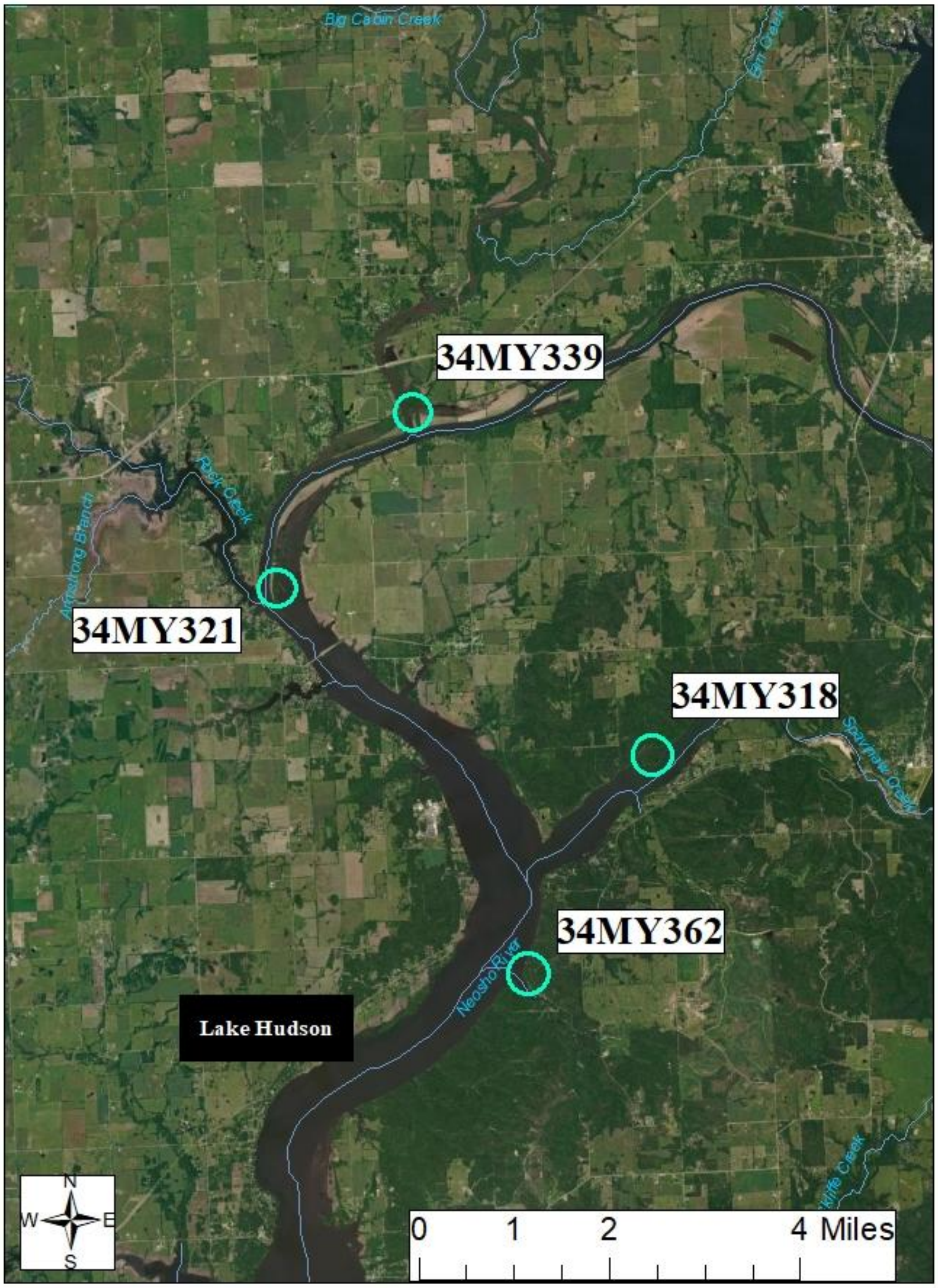

Figure 5. Vicinity of 34MY320/21, 34MY318, 34MY339, 34MY362.

In 2010, Ron Yost and his wife contacted Dr. Robert Brooks, then State Archaeologist of Oklahoma, to determine if the Oklahoma Archaeological Survey (OAS) would be interested in curating the cultural materials the family had collected, because the Yosts planned to move out of state. The Yost family had not recorded the exact provenience of each artifact, but they were able to confidently indicate the map locations of the artifact concentrations from which they had collected (Brooks 2012:31). Projectile-points were collected from the ground surface. The Yosts were interested in the potential for the artifacts to provide information on the past, and they intentionally collected with a bias toward artifacts that they thought might be diagnostic. Brooks agreed to accept the artifacts, and in January of 2011, the Yosts formally donated the collection to the Oklahoma Archeological Survey (OAS).

The Yost Collection includes 522 projectile-points ranging in age from the early Archaic through the Woodland Periods (8,000 BCE to 1,300 CE). Brooks' initial research involving the Yost Collection did not emphasize the projectile points or delve specifically into the implications of the shift from notched points to the inclusion of stemmed point designs captured in the Yost collection. Brooks' research instead focused on the best evidence for early horticulture and agriculture such as manos, metates, hammerstones, and stone hoes within the overall collection context (Brooks 2012). The dart and arrow point assemblage contains representative artifact types spanning the entire time-range in which the transition from highly mobile foraging to residentially sedentary collecting and eventual agriculture took place in northeastern Oklahoma. The Yost Collection point assemblage is a particularly useful source of data for analysis and interpretation utilizing the theoretical models set forth by Binford (1978; 1980) and Bleed (1986; 1987), as discussed in Chapter 2. The next chapter will describe the Yost Collection projectile-point assemblage from Lake Hudson and provide typological classifications and descriptive profiles for each point type present.

Chapter 4: Research Assemblage and Typology

As the first step in my analysis, I adopted a relative-dating projectile point typology to provide chronological sequencing for the assemblage. Although numerous typologies have been applied to Oklahoma projectile-points, I utilized the *Guide to the Identification of Certain American Indian Projectile Points*, Volumes 1-4, by Bell and Perino for my purposes (Bell 1958, 1960; Perino 1968, 1971). This is the most widely utilized and often-cited typology in the archaeological literature for Oklahoma. The Bell and Perino point-type age estimates were augmented by date-range estimates from Vehik (1984) and Turner, Hester and McReynolds (2011) as needed to clarify information gaps or insufficient descriptions in the original typologies. Vehik (1984) was relied on as the final authority when dates conflicted between sources. Using these sources in this manner ensures consistency between my research and that of past and likely future researchers, which facilitates meaningful comparisons of technologies through time and across space.

Research Sample Selection

Accurately assigning artifacts to any typological category requires a minimum essential degree of intact morphological landmarks (i.e. intact barbs, stem, blade, etc). Nine of the 556 projectile points within the full assemblage were in exceptionally poor condition and lacked enough diagnostic morphological landmarks to reliably categorize them to individual types. These nine points were removed from the research sample because of the inability to assign them to date-ranges of manufacture and use-life.   Thirty-four individual specimens classified as arrow points were then removed from the analysis. This was done because they were introduced to the Lake Hudson study area very late in the time-frame of this study, they were numerically under-represented, and cross-comparison between arrow and spear points provides differing data due to differing design, hafting and ballistics considerations. Seven identifiable point types were present in quantities of three or fewer. These types were retained in the research sample due to their potential to provide information regarding less common or transitory cultural occurrences in the Lake Hudson vicinity. This removal and retention strategy yielded a research sample of 522 points divided among 18 types that robustly represented the Archaic through the Woodland periods in Oklahoma.

Typology Assignment

The final sample includes eighteen point types.

Table 6. Point Type Quantities and Percentages in Study Sample.

Type	Total Number in Sample	Percentage of Research Sample
Gary	142	27.20
Langtry	82	15.70
Ellis	59	11.30
Ensor	57	10.91
Williams	51	9.77
Marcos	40	7.66
Marshall	32	6.13
Afton	14	2.68
Edgewood	13	2.49
Lange	12	2.29
Snyders	9	1.72
Uvalde	3	0.57
Cupp	2	0.38
Smith	2	0.38
Frio	1	0.19
St. Charles	1	0.19
Stanley	1	0.19
Yarbrough	1	0.19

The notched spear-point portion of the assemblage includes Afton, Cupp, Edgewood, Ellis, Ensor, Frio, Lange, Marshall, Marcos, Smith, Snyders, St. Charles, Stanley, Uvalde, Williams and Yarbrough point types. The stemmed points include Gary and Langtry types. Below I have provided essential typological information for each point type present in the research assemblage, and I have included photographs of the best representative points for each type.

Numerically Well-Represented Point Types (9 or more present in study sample)

Gary

Gary Points		
	**Morphology**	Tapered contracting stem with rounded base. Triangular blade with typically flaring shoulders. (Bell 1958)
	Dates	c. 1 CE – 1,300 CE (Bell 1958; Vehik 1984:185)
	Geographic Distribution	Oklahoma, Arkansas, Louisiana, Mississippi, etc. (Bell 1958)

Figure 6.

Langtry

Langtry Points		
	**Morphology**	Tapered contracting stem with straight or concave base. Triangular blade with typically flaring shoulders. (Bell 1958)
	Dates	c. 1 CE – 1,300 CE (Bell 1958; Vehik 1984:185)
	Geographic Distribution	Oklahoma and Texas. (Bell 1958)

Figure 7.

Ellis

Ellis Points		
	**Morphology**	Expanding stem with rounded or straight base nearly as large as shoulders. Triangular blade. (Bell 1960)
	Dates	1,000 BCE – 500 CE (Bell 1960)
	Geographic Distribution	Oklahoma, Texas, Mississippi Basin. (Bell 1960)

Figure 8.

Ensor

Ensor Points		
	**Morphology**	Side notched dart point, short wide expanding stem, straight base; the tangs flush with blade edge. (Bell 1960)
	Dates	1,000 BCE – 500 CE Possibly earlier and later. (Bell 1960)
	Geographic Distribution	Oklahoma and North and Central Texas. (Bell 1960)

Figure 9.

Williams

Williams Points

Morphology	Dart point with expanding stem and convex base, convex triangular blade, barbed shoulders, corner notched. (Bell 1960; Turner, Hester and McReynolds 2011)
Dates	4,000 BCE – 1,000 CE (Bell 1960; Vehik 1984:185)
Geographic Distribution	Central and East Texas, Eastern Oklahoma, and the Mississippi Valley. (Bell 1960)

Figure 10.

Marcos

Marcos Points

Morphology	Corner notched expanding stem dart point, triangular blade, deep notches 45 degree angle. (Bell 1958)
Dates	4,000 BCE – 1,000 CE (Bell 1958; Vehik 1984:185)
Geographic Distribution	Central Texas and Texas Coast, Eastern Oklahoma. (Bell 1958)

Figure 11.

Marshall

Marshall Points		
	**Morphology**	Large dart point, oval shaped blade, corner or basal notches, strongly barbed, straight or concave base. (Bell 1958)
	Dates	3,000 BCE – 1,000 CE (Bell 1958; Vehik 1984:185)
	Geographic Distribution	Central Texas and Eastern Oklahoma. (Bell 1958)

Figure 12.

Afton

Afton Points		
	**Morphology**	Large dart point, double angled blade with triangular point and steeper sides, large barbs. (Bell 1958)
	Dates	3,000 BCE – 1 BCE (Bell 1958)
	Geographic Distribution	Ohio Valley, Southwest Missouri, Southeast Kansas, Northwest Arkansas, Northeast Oklahoma. (Bell 1958)

Figure 13.

Edgewood

<table>
<tr><th colspan="3">Edgewood Points</th></tr>
<tr><td rowspan="3">
</td><td>Morphology</td><td>Small dart point, short triangular blade, expanding stem, concave base, often beveled on right edge of both faces. (Bell 1958)</td></tr>
<tr><td>Dates</td><td>200 BCE – 200 CE
(Bell 1958; Turner, Hester and McReynolds 2011)</td></tr>
<tr><td>Geographic Distribution</td><td>Central and North Central Texas, Oklahoma, Mississippi Valley.
(Bell 1958)</td></tr>
</table>

Figure 14.

Lange

<table>
<tr><th colspan="3">Lange Points</th></tr>
<tr><td rowspan="3">
</td><td>Morphology</td><td>Medium to large dart point, convex triangular blade, occasional concave tip, well barbed shoulders, often expanding stem edges. (Bell 1958)</td></tr>
<tr><td>Dates</td><td>4,000 BCE – 1,000 CE (Bell 1958)</td></tr>
<tr><td>Geographic Distribution</td><td>Texas, Oklahoma.
(Bell 1958)</td></tr>
</table>

Figure 15.

Snyders/Cooper Points

	**Morphology**	Large broad corner notched dart point, ovate blade, expanding stem, wide deep notches and bold barbs. (Bell 1958)
	Dates	Snyders 500 BCE – 500 CE (Bell 1958) Cooper 900 – 1300 CE (Vehik 1984)
	Geographic Distribution	Central and Northern Illinois, Southwest Michigan, East Missouri, Northeast Oklahoma, Ohio Valley and Central Mississippi Valley. (Bell 1958)

Figure 16.

Numerically under-represented Point Types (3 or fewer of each type present) and Omitted arrow-point types.

Figure 17. Left to Right: St. Charles, Cupp, Uvalde point types.

Figure 18. Left to Right: Yarbrough, Sequoya (arrow), Cliffton (arrow), and heavily reworked Ellis point types.

Figure 19. Left to Right: Smith, Frio and Stanley point types.

Uvalde

Uvalde Points	
Morphology	Medium dart point with a flared stem and deeply concave base. Triangular or leaf-shaped blade. Strong, rounded and barbed shoulders. (Bell 1960)
Dates	4,000 BCE – 1,000 CE (Bell 1960)
Geographic Distribution	Central and coastal Texas and parts of Oklahoma. (Bell 1960)

Figure 20.

Smith

Smith Points	
Morphology	Large dart point with straight stem, convex blade and basal notches. (Perino 1968)
Dates	6,000 BCE – 1,000 CE (Perino 1968)
Geographic Distribution	Arkansas, Oklahoma, Missouri, Texas, Illinois. (Perino 1968)

Figure 22.

Cupp

Cupp Points	
Morphology	Medium to large dart point with a bulbous stem and long straight blade. Large notches and convex base. (Perino 1971)
Dates	500 CE – 1,400 CE (Perino 1971)
Geographic Distribution	Northeast Oklahoma, Southwest Missouri, Northwest Arkansas, and Southeast Kansas. (Perino 1971)

Figure 21.

Frio

Frio Points	
Morphology	Small to medium corner-notched dart point with recurved expanding base and typically strong barbed shoulders. Center basal notch. (Bell 1960)
Dates	4,000 BCE – 500 CE (Bell 1960)
Geographic Distribution	West-central and south-central Texas, and central and eastern Oklahoma. (Bell 1960)

Figure 23.

St. Charles

St. Charles Points	
Morphology	Large corner-notched dart point with an ovate blade, expanding stem and convex base (Bell 1960)
Dates	2,000 BCE – 1 CE (Bell 1960)
Geographic Distribution	Ohio Valley, Missouri, Pennsylvania, West Virginia, Kentucky, Michigan, Wisconsin, Iowa, Arkansas, Tennessee, etc. (Bell 1960)

Figure 24.

Table 7. Point Types and Date Ranges.

Type	Date Range	Median Date (Rounded to nearest decade)
Gary	1 CE – 1,300 CE	650 CE
Langtry	1 CE – 1,300 CE	650 CE
Ellis	1,000 BCE – 500 CE	250 BCE
Ensor	1,000 BCE – 500 CE	250 BCE
Williams	4,000 BCE – 1,300 CE	1,350 BCE
Marcos	4,000 BCE – 1,300 CE	1,350 BCE
Marshall	3,000 BCE – 1,300 CE	850 BCE
Afton	3,000 BCE – 1 CE	1,500 BCE
Edgewood	200 BCE – 200 CE	1 BCE
Lange	4,000 BCE – 1,000 CE	1,500 BCE
Snyders/Cooper	500 BCE – 500 CE / 900 CE – 1300 CE	1 BCE / 1,100 CE
Uvalde	4,000 BCE – 1,000 CE	1,500 BCE
Cupp	500 CE – 1,400 CE	950 CE
Smith	6,000 BCE – 1,000 CE	2,500 BCE
Frio	4,000 BCE – 500 CE	1,750 BCE
St. Charles	2,000 BCE – 1 CE	1000 BCE
Stanley	6,000 BCE – 4,000 BCE	5,000 BCE
Yarbrough	500 BCE – 1,000 CE	250 CE

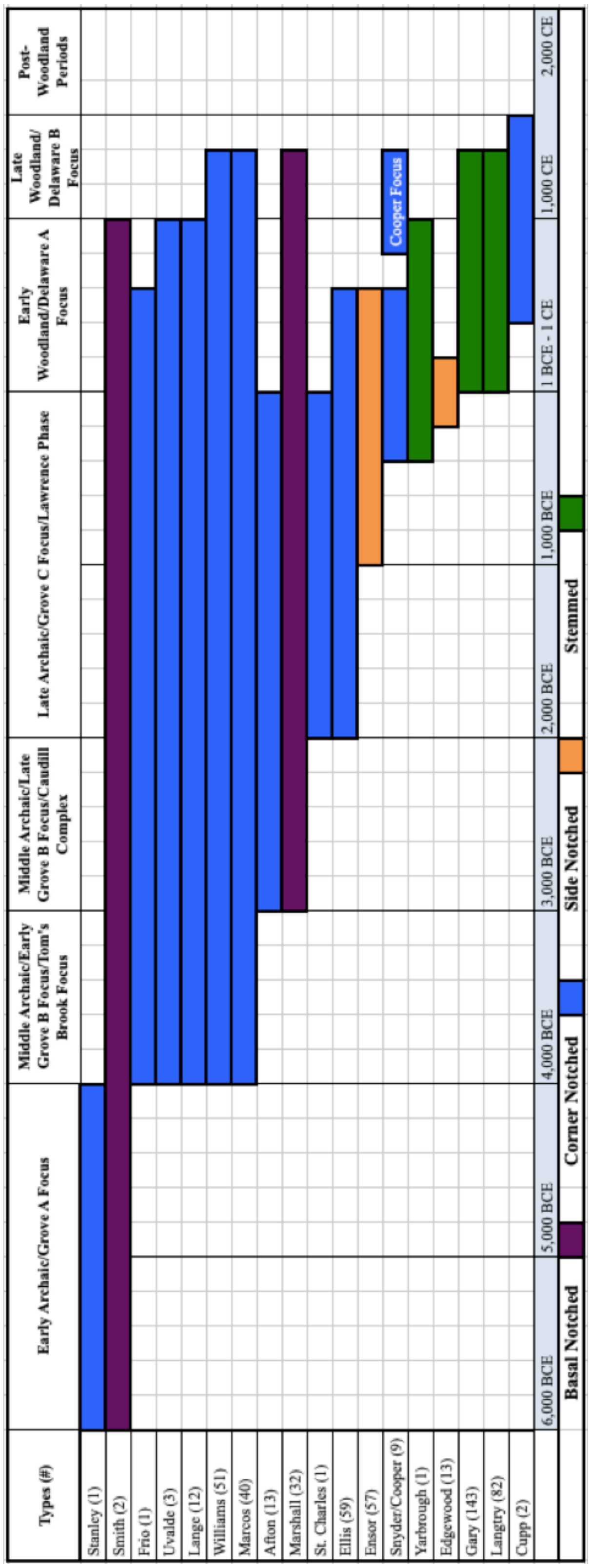

Figure 25. Yost Collection morphology, point type age-ranges, and culture history periods.

Table 8. NE Oklahoma culture history periods and contemporaneous Yost Collection point types.

Period/Phase/Complex	Date Range	Point Types Typically Present in NE Oklahoma (Present in Yost Collection)	Less Common Point Types in NE Oklahoma (Present in Yost Collection)
Early Archaic/Grove A Focus	6,000 BCE - 4,000 BCE	Smith	Stanley
Middle Archaic/Early Grove B Focus/Tom's Brook Focus	4,000 BCE - 3,000 BCE	Uvalde, Frio, Williams, Marcos, Smith	Lange
Middle Archaic/Late Grove B Focus/Caudill Complex	3,000 BCE - 2,000 BCE	Smith, Marshall, Marcos, Uvalde, Frio, Williams, Afton	Lange
Late Archaic/Grove C Focus/Lawrence Phase	2,000 BCE - 1 BCE	Frio, Afton, Ellis, Marcos, Marshall, Williams, Ensor, Edgewood, Smith	Yarbrough, St. Charles, Lange
Early Woodland/Delaware A Focus/Cooper Focus – Overlapping (900 – 1,100 CE)	1 CE - 1,000 CE	Gary, Langtry, Marcos, Marshall, Williams, Snyders/Cooper, Smith,	Cupp, Lange
Late Woodland/Delaware B Focus/ Cooper Focus – Overlapping (900 – 1,100 CE)	1,000 CE - 1,300 CE	Gary, Langtry, Snyders/Cooper, Marshall, Marcos, Williams,	Cupp

Chapter 5: Methods

I conducted a series of quantitative metric examinations and qualitative presence-absence evaluations to analyze the projectile points in the Yost Collection assemblage. These methods yielded data regarding design complexity, trends in alteration of point design, shifts in weapon-system rework and curation, and changes in manufacturing and hunting technology investment over time. I begin this chapter with a summary of my methods and then describe all techniques in greater detail.

As discussed in Chapter 4, I began my study by omitting nine extremely incomplete and typologically unidentifiable specimens. I then proceeded to assign each of the remaining 556 artifacts a typological label by comparing their morphology with the most commonly referenced Oklahoma typology point-guides (Bell 1958, 1960; Perino 1968, 1971). Thirty-four specimens classified as arrow points were then removed from the analysis. This was done because they were introduced to the Lake Hudson study area at an indeterminate point very late in the time-frame of this study, they were under-represented, and cross-comparison between arrow and spear points provides differing data due to differing hafting and ballistics considerations. This resulted in a final study assemblage of 522 projectile points. I next photographed prototypical examples of each artifact type in the resulting study sample represented by about 9 or more present specimens, and I evaluated each using the attribute analysis methods described below. Finally, I saved all data in spreadsheet format before statistically analyzing the data using the *JMP 14 SW* statistical program. The data analysis was focused on revealing chronological trends involving changes to artifact attributes over the six culture-history time period sub-divisions established for the Archaic and Woodland periods within the study area. These statistical data manipulation methods are described in the last section of this chapter.

Attribute Analysis Metrics

I estimated the degree of completeness versus incompleteness of each point using a cut-off of 80% or greater total completeness required before a specimen was listed as “complete”. This method was adapted from Pitblado (2003) and facilitates a more uniform and replicable assessment of the percentage of broken points. A large percentage of incomplete points were still present within all analyzed point type categories. This made some design element measurements impossible for broken points with incomplete or missing areas. Individual attributes – such as blade length - that were not measurable because they were incomplete were left blank, indicating “Indeterminate due to missing attribute.”

Table 9. Qualitative Presence/Absence Evaluations.

Qualitative
Presence/Absence of Completeness
Presence/Absence of Heat Treatment
Presence/Absence of Cortex
Presence/Absence of Rework

In addition to the above listed qualitative observations, I measured and weighed the points using metric criteria and techniques based on those used by Andrefsky (2005). Andrefsky’s system provides an extensive degree of metric data regarding the artifacts and is applicable to both notched and stemmed point morphologies, making it ideal for this study, because my research relies on observing all measurable changes in projectile-point morphology through time. I used digital calipers to measure the following angles and elements on all specimens. All dimensional measurements were taken to the nearest tenth of a millimeter, and in the case of weight, to the nearest tenth of a gram. Table 8 lists all the quantitative metrics recorded.

Table 10. Quantitative Projectile-Point Metrics.

Quantitative
Weight (10ths of a gram)
Maximum Thickness (mm)
Neck Width (NW) (mm)
Haft Length/Neck Height (HL/NH) (mm)
Blade Width (BLW) (mm)
Base Width (BW) (mm)
Blade Length (BLL) (mm)
Shoulder to Corner (SBC) (mm)

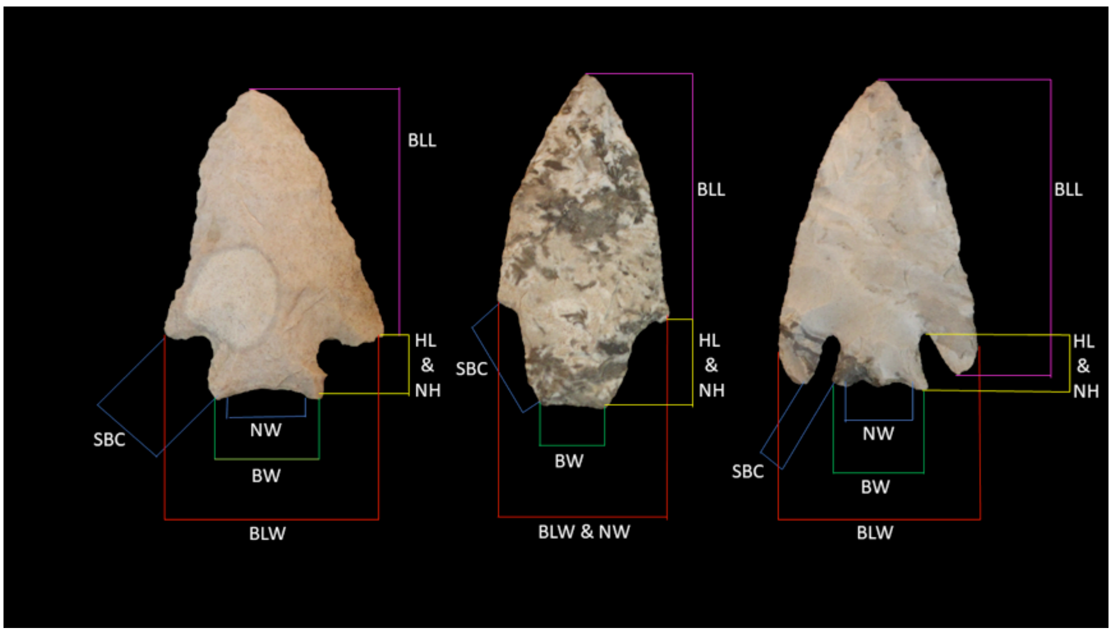

Figure 26. Attribute Metrics examples. (Adapted from Andrefsky, 2005)

Artifact Retouch

I applied a measurement technique called an "index of invasiveness" to each specimen to quantify retouch. This indexing method was devised by Chris Clarkson (2002) and involves dividing each face of a point into 16 analytical segments, and dividing each segment into two "zones" – inner and outer (Figures 30 and 31). I examined each zone for retouch flake scars and assigned an invasiveness score, which quantifies how far retouch scars extend across a point's surface toward its medial axis. Retouch flake scars are defined as secondary flaking along the point edge that is found over the original manufacturing flake scars. A segment with flake scars that extended medially to the outer zone received a score of 0.5 and those with scars that extended to the inner zone received a score of 1. I then totaled the segment scores for each specimen and divided them by 16, completing Clarkson method. Finally, the scores were rounded to the nearest tenth to produce the final index of invasiveness – or retouch score – for each artifact.

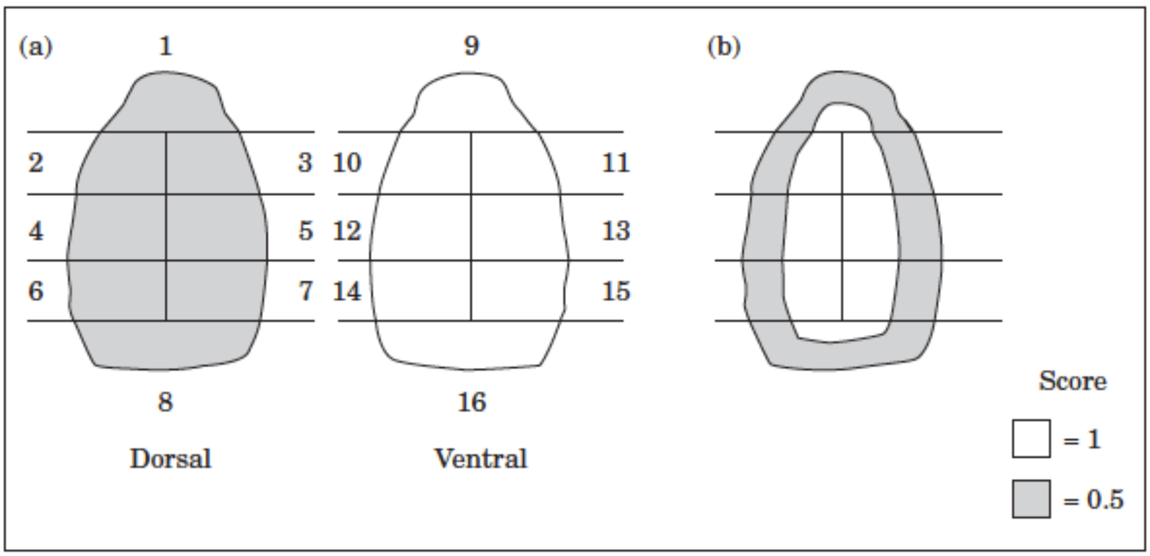

Figure 27. Method for dividing artifact surfaces into segments and zones (Courtesy of Clarkson 2002, Figure 1).

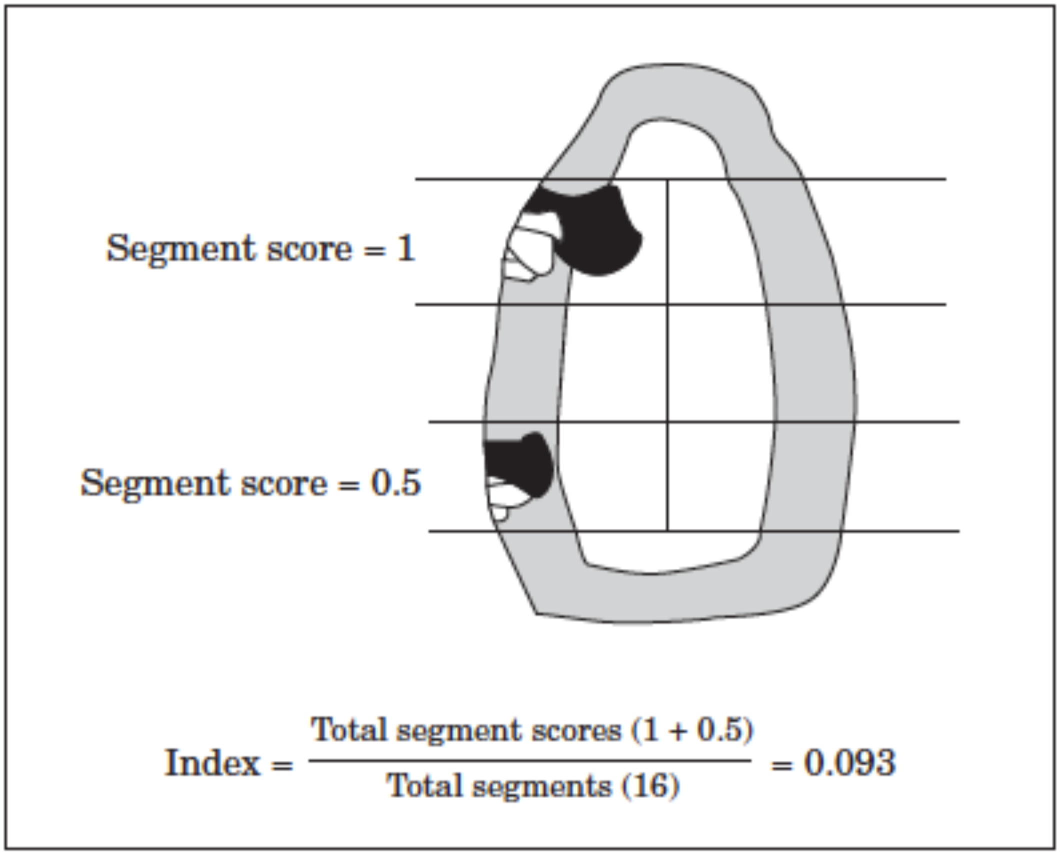

Figure 28. Example application of the invasiveness scoring technique. (Courtesy of Clarkson 2002, Figure 2).

All metric attribute assessment data was then recorded in a *Microsoft Excel* (Excel) spreadsheet using a coding system adapted from Pitblado (2003) (See Appendix A). This system allows data to be efficiently entered into data tables compatible with the *JMP* software application for statistical analysis.

Data Manipulation

After the artifact analysis was completed the metric variable data (Tables 5 & 6; Figures 30-32) was input into a data table in the *JMP 14 SW* statistical analysis program. Eleven variables were identified as important for testing the technological postulates. Weighted averages of these were calculated for each of the six time periods listed in Chapter 3 (Table 9). These partially weighted averages were calculated using the Weighted.Desc.Stat library in R (Parchami 2016). These averages were created by assuming that a point type that was made in more than one time period was equally likely to have been made in each of the periods of manufacture. These divisions provided the chronological control necessary to observe changes to the metric data over time because the projectile-point types provided overlapping date-ranges often encompassing multiple cultural time periods. A disadvantage to this approach lies in the fact that not all point types that existed during Periods A and B were present to an identical and equal degree in both time periods. However, by partially weighting the point metric data it is dispersed more evenly across all time periods in which a point type was made. Partial weighting of data across periods is derived from initial concepts that the data is grouped by point type and each type that was present over multiple time periods is numerically divided evenly across those time periods. For example, Ellis-type points were produced during parts of three time periods, while Ensor points have been made during only two periods. The 59 Ellis points were statistically divided by three, splitting data from 19.66 Ellis points into each of its three periods. The data from the 57 Ensor points were divided among two periods, partially weighting each period. This method prevents the data from time periods with a large variety of point types from drowning out the statistical data from periods with a smaller variety of types. Standard Error confidence intervals were also calculated for each of these variables.

The data was recorded for the following criteria for each chronological division:

Table 11. Statistical analysis variables for forager/collector trend determination.

Percentage of Complete Specimens
Percentage of Reworked Specimens
Percentage of Heat Treated Specimens
Percentage of Specimens with Cortex Present
Mean Index of Invasiveness (Complete Specimens Only)
Mean Stem-to-Length Ratio (Haft length subtracted from total length, then the two whole numbers are divided by the greatest common divisor to provide the simplified ratio)
Mean Weight as a measure of size (Complete Specimens Only)
Base Width Coefficient of Variation (Measure of Haft Area Standardization)
Neck Width Coefficient of Variation (Measure of Haft Area Standardization)
Haft Length Coefficient of Variation (Measure of Haft Area Standardization)
Mean Maximum Thickness

Chapter 6: Analysis

This research is designed to tell us when and at what tempo the people of the Lake Hudson area of the Neosho and Grand River Drainage shifted from the more residentially-mobile Forager lifeway of the Early Archaic Period to the primarily residentially stationary Collector strategy of the Late Woodland Period. The archaeological record provides much evidence for these changes such as the built environment, grinding stones, and processing tools. The observed changes in spear points over time provide further necessary data. In essence, from the design and use-life of the hunting technology we will be able to infer the land-use and subsistence strategy of local groups during the Archaic and Woodland Periods. This chapter will present the results of the observational methods and statistical data manipulation procedures described in Chapter 4 and discuss the patterns present within these results based on the Forager/Collector interpretive matrix described in Chapter 2. An in-depth discussion of the theoretical implications of these patterns will be presented in the next chapter.

In terms of design, the 522 specimens represent 18 projectile-point types temporally spanning from the Early Archaic Period to the terminal Woodland Period. Refer to Table 4 in Chapter 4 for the quantity of each type present and the percentages of each type in the study sample. Eleven of the types represented are morphologically corner-notched, two types are basally-notched, two are side-notched, and three types are stemmed. 517 of the total Yost Collection point assemblage specimens were manufactured from chert, with 498 of these made from Ozark Plateau cherts. 19 points were knapped from non-local chert and two were made of quartzite. Three specimens were made from rhyolite, novaculite, and petrified wood, respectively.

General Assemblage Observations

From a condition and usage perspective, 274 specimens show signs of impact fracturing and 253 total specimens were incomplete (<80% complete). 268 points have been reworked to some degree, of which 246 were resharpened for continued use as projectile-points and 22 were retooled for use as drills, awls, or scrapers. The Index of Invasiveness scoring system previously detailed in Chapter 4 was used to measure the degree of retouch present on each artifact. Sixteen spear points tallied a maximum Index of Invasiveness score of 1, indicating that both faces were completely retouched. Invasiveness scores varied widely from the maximum to a low as 0.2. Eighteen total specimens have cortex present and 55 show evidence of heat treatment during manufacture.

To determine the timing and manner of Grand River inhabitants' shift from foraging to collecting strategies I began by searching for significant shifts in metric data by temporal period. A statistical shift from one period to the next was considered significant if there were no overlapping error bars. The eleven metrics analyzed are described as follows:

Mean Weight

Mean weight is being examined as a corollary of overall point size because Kuhn (1989) argued that Forager systems are likely to use tools to exhaustion, leading to smaller mean tool sizes, and Bleed (1986) posited that Forager systems are likely to use smaller and lighter tools that might be reworked in haft. In contrast, Collector's systems are likely to use heavier and larger tools, to discard them rather than repair them, and to engage and less reworking. The archaeological record indicates that deer were the primary prey of hunters during the Middle Archaic through Woodland Periods in the study area. This consistent faunal target-size would not have provided impetus for changes in point size, nor would the abundance of quality local tool stone have compelled design changes to conserve material. Thus changes in mean weight are likely related to shifts in residential versus logistical mobility, and weight decreases suggest a shift to more of a Forager and less of a Collector strategy.

Among the assemblage, point size – measured in terms of mean weight per temporal period – decreased substantially from a high of 25.7 grams (g) in the Early Archaic to all following periods (Figure 32). The low total of specimens representing the early Archaic produces a degree of statistical uncertainty. Weights for the later five periods remain relatively steady, with no major shifts.

Thus, using the mean weight variable in insolation, we might conclude that the Early Archaic was more of a Collector system that shifted toward more of a Forager system in the subsequent periods.

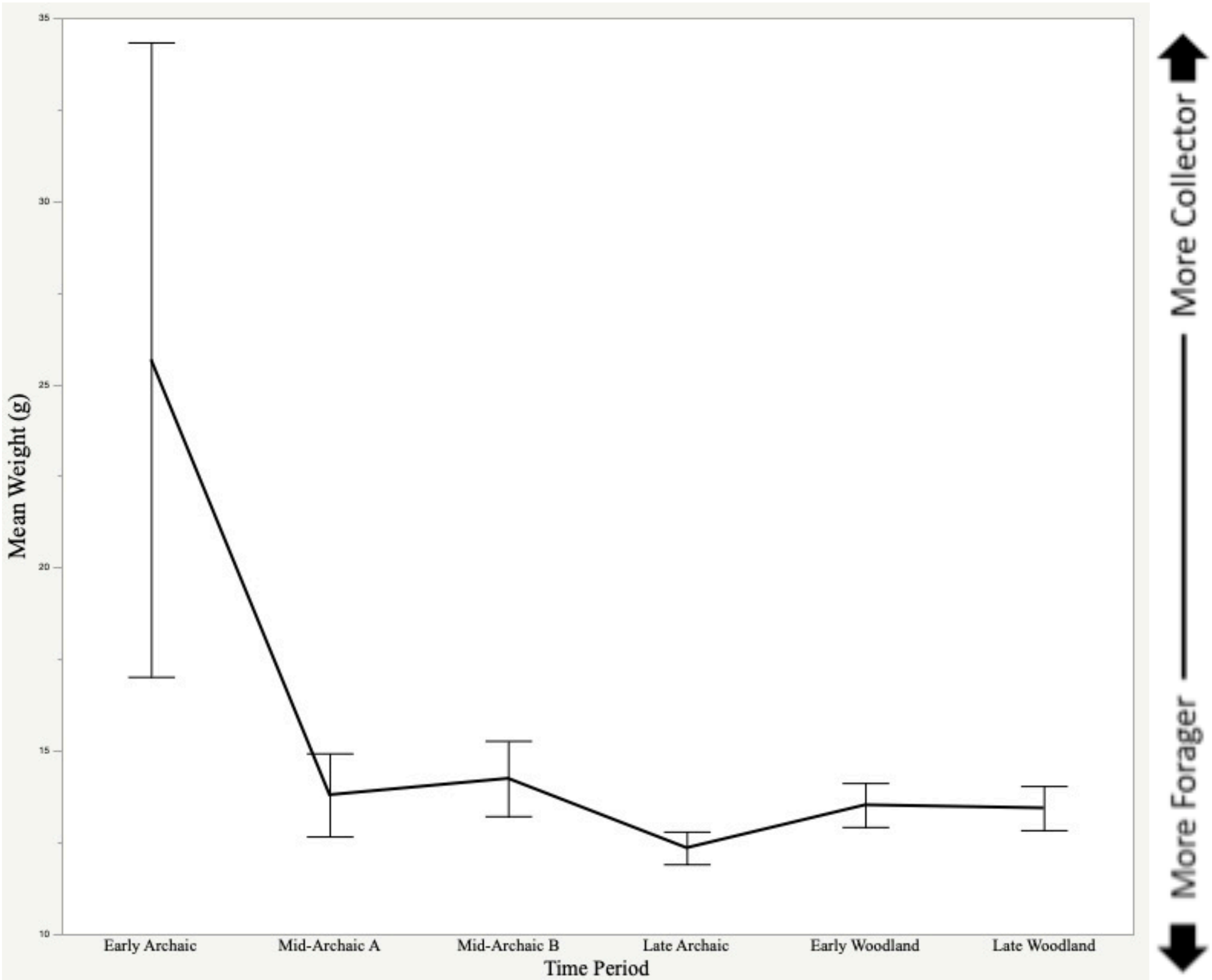

Figure 29. Weight (g) mean by Time Period.

Haft Length Coefficient of Variation

Haft length variation is being examined because Nelson (1991) posited that Forager systems are likely to invest less attention to hafting, resulting in less standardization between the hafting areas of different spear points. In contrast, Collector systems would exhibit greater standardization in the dimensions of haft areas due to more attention devoted to hafting. Thus increases in haft standardization suggest a shift to more of a Collector and less of a Forager strategy. Haft length variation metrics produced an initially very wide range in Early Archaic points. Variation decreased by the Middle Archaic/Grove B/Tom's Brook Focus and remained steady during the remainder of the Mid-Archaic. During the Late Archaic, there was a subtle decrease in haft length variation. This slightly reduced amount of variation overlapped with previous and succeeding periods, remaining stable throughout the Woodland Period (Figure 33).

Thus, using haft length coefficient of variation to examine haft design attention and standardization, we might conclude that haft length became slightly more standardized during the Late Archaic. This level of standardization continued during the Woodland Period. However even with the slight drop in variation from the Middle-to-Late Archaic the numbers do not indicate any statistically significant shifts, as all error bars were overlapping. The slight overall decrease in variation could be seen as a forager system that temporarily shifted toward more of a collector system during the Late Archaic, but this overlapping level of variation was maintained during the subsequent Woodland period. Haft length variation metrics have not provided significant evidence of major changes in tool standardization.

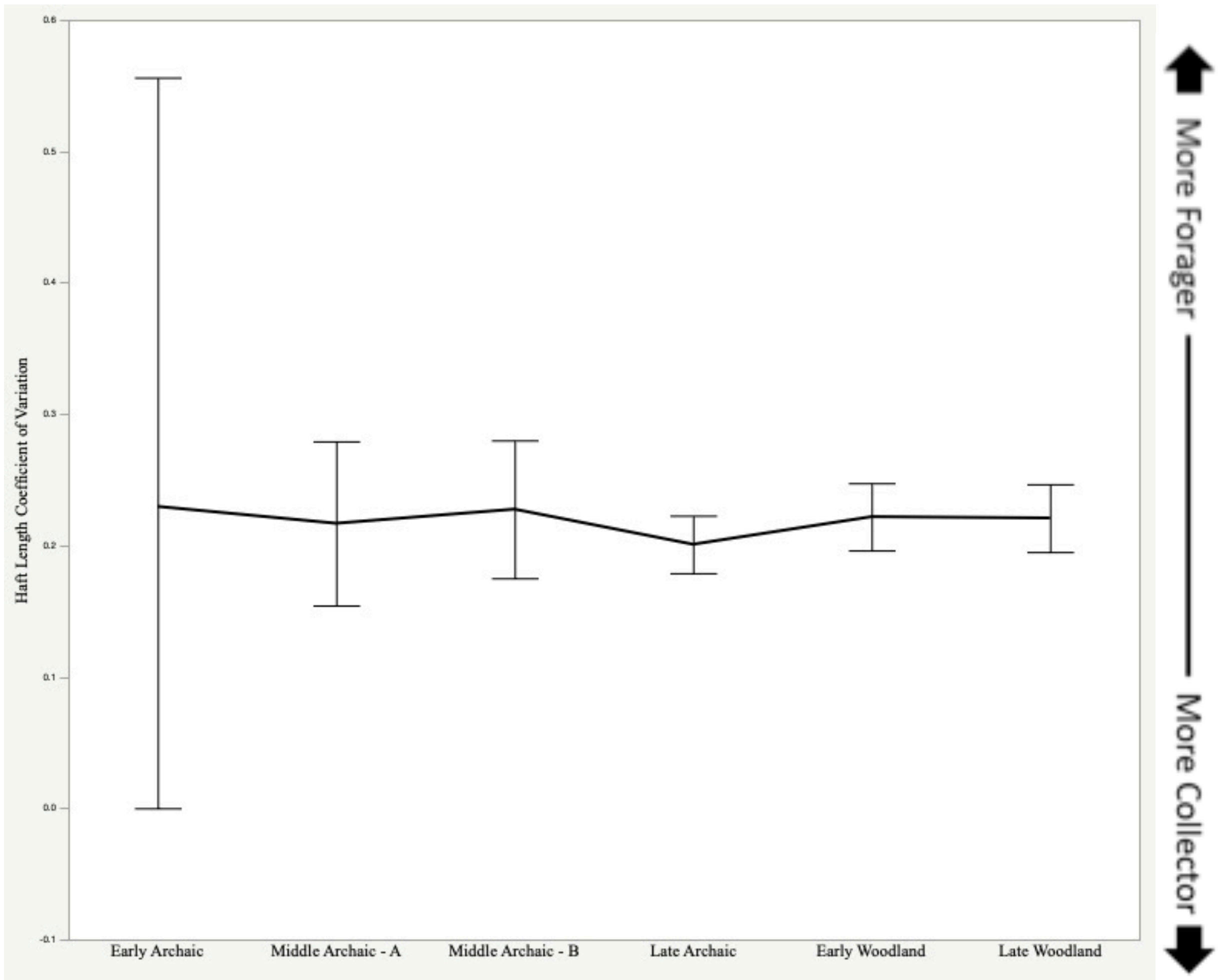

Figure 30. Haft Length (mm) Coefficient of Variation by Time Period.

Neck Width Coefficient of Variation

Neck width variety is being examined because Nelson (1991) posited that Forager systems are likely to invest less attention to hafting area design, resulting in less standardization between the hafting areas – including neck width - of different spear points. In contrast, Collector systems are likely to exhibit greater standardization in the dimensions of haft areas due to more attention devoted to hafting. Thus, increases in haft standardization suggest a shift to more of a Collector and less of a Forager strategy.

Neck width in the Early Archaic exhibits a high degree of variation that dropped precipitously during the Middle Archaic. The remainder of the Archaic was relatively consistent with lower levels of statistically overlapping neck width variation. Early Woodland/Delaware A Focus neck widths show an increase in mean neck width, but a similarly narrow range of variation that persisted through the Late Woodland/Delaware B Focus. The Woodland Period ranges of variation are statistically significantly different from the Middle and Late Archaic numbers, however the Early Archaic range of variation overlaps them. This Archaic to Woodland statistical leap correlates somewhat with the observed trends in haft length variation during the same period (Figure 34).

Thus, using neck width variability to examine haft design attention and standardization, we might conclude that the Middle and Late Archaic was focused on more of a Collector system. It may have been both preceded and succeeded by more of a Forager-focused system. The significance of this data is weakened by the high degree of overlapping error ranges.

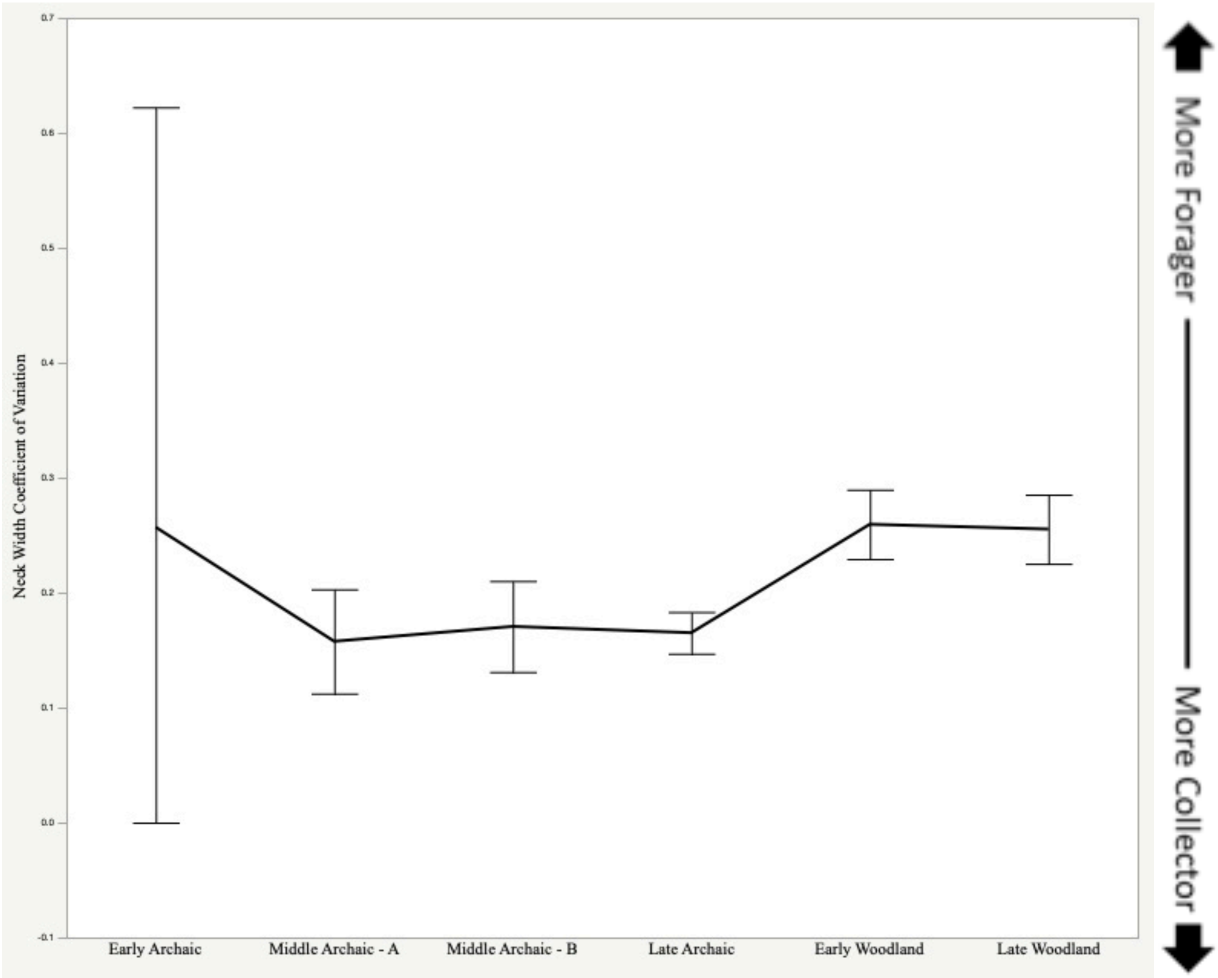

Figure 31. Neck Width (mm) Coefficient of Variation by Time Period.

Base Width Coefficient of Variation

Base width variation is being examined because Nelson (1991) posited that Forager systems are likely to invest less attention to hafting area design, resulting in less standardization between the hafting areas – including base width - of different spear points. In contrast, Collector systems are likely to exhibit greater standardization in the dimensions of haft areas due to more attention devoted to hafting. Increases in haft standardization suggest a shift to more of a Collector and less of a Forager strategy.

Base width in the Early Archaic exhibits a high degree of variation that dropped precipitously during the Middle Archaic. The remainder of the Archaic was relatively consistent with lower levels of statistically overlapping base width variation. Early Woodland/Delaware A Focus base widths show an increase in mean base width, but a similarly narrow range of variation that persisted through the Late Woodland/Delaware B Focus. The Woodland Period ranges of variation are statistically significantly different from the Middle and Late Archaic numbers, however the Early Archaic range of variation overlaps them. This Archaic to Woodland statistical leap correlates somewhat with the observed trends in haft length and neck width variation during the same period (Figure 35). Thus, using base width variability to examine haft design attention and standardization, we might conclude that the Middle and Late Archaic was focused on more of a Collector system. It may have been both preceded and succeeded by more of a Forager-focused system. This inference is tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

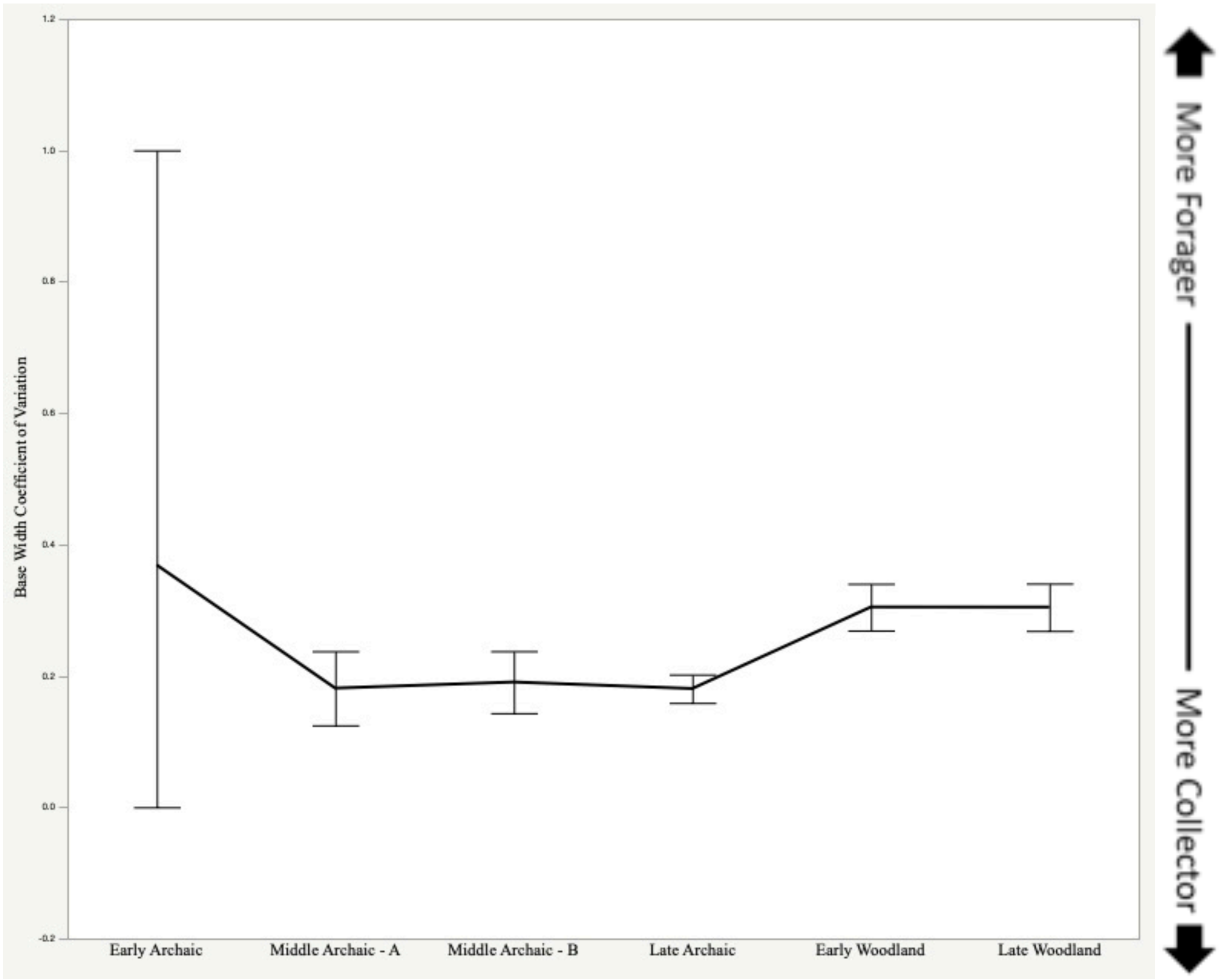

Figure 32. Base Width (mm) Coefficient of Variation by Time Period.

Haft Standardization

A similar pattern emerges when the three hafting area metrics of neck width, base width, and haft length are examined for coefficient of variation and cross-referenced (Figure 36). Observed trends toward low variability represent shifts in the direction of greater Collector behavior. Likewise, increases in variation represent shifts toward the Forager strategy end of the spectrum. All three hafting area metrics exhibit heavy overlapping of error bars, which decreases the statistical significance. Regardless, a trend is common among all three. The Archaic Period exhibited a gradual shift toward increasing Collector strategies, culminating during the Late Archaic. A modest reversal of that trend is observable across all three variables during the Woodland Period, possibly indicating a return of some more Forager activities into the life-ways of local inhabitants during that time. Overall, hafting area neck and base widths remained quite consistently similar throughout all time periods, becoming much more standardized the Middle and Late Archaic periods. Haft length did not become highly standardized until the Late Archaic, at which point it was highly similar to neck width and base width in terms of variation. Haft length proceeded apace with the other haft metrics in a very similar and sharp increase in variation throughout the Woodland. This decreased variability and increased standardization during the Middle and Late Archaic corresponds with expectations set forth by Nelson (1991) that systems, which focus more attention on hafting, are likely to be Collectors. The strong increase in variation for all three metrics during the Woodland appears to indicate more forager-like tendencies.

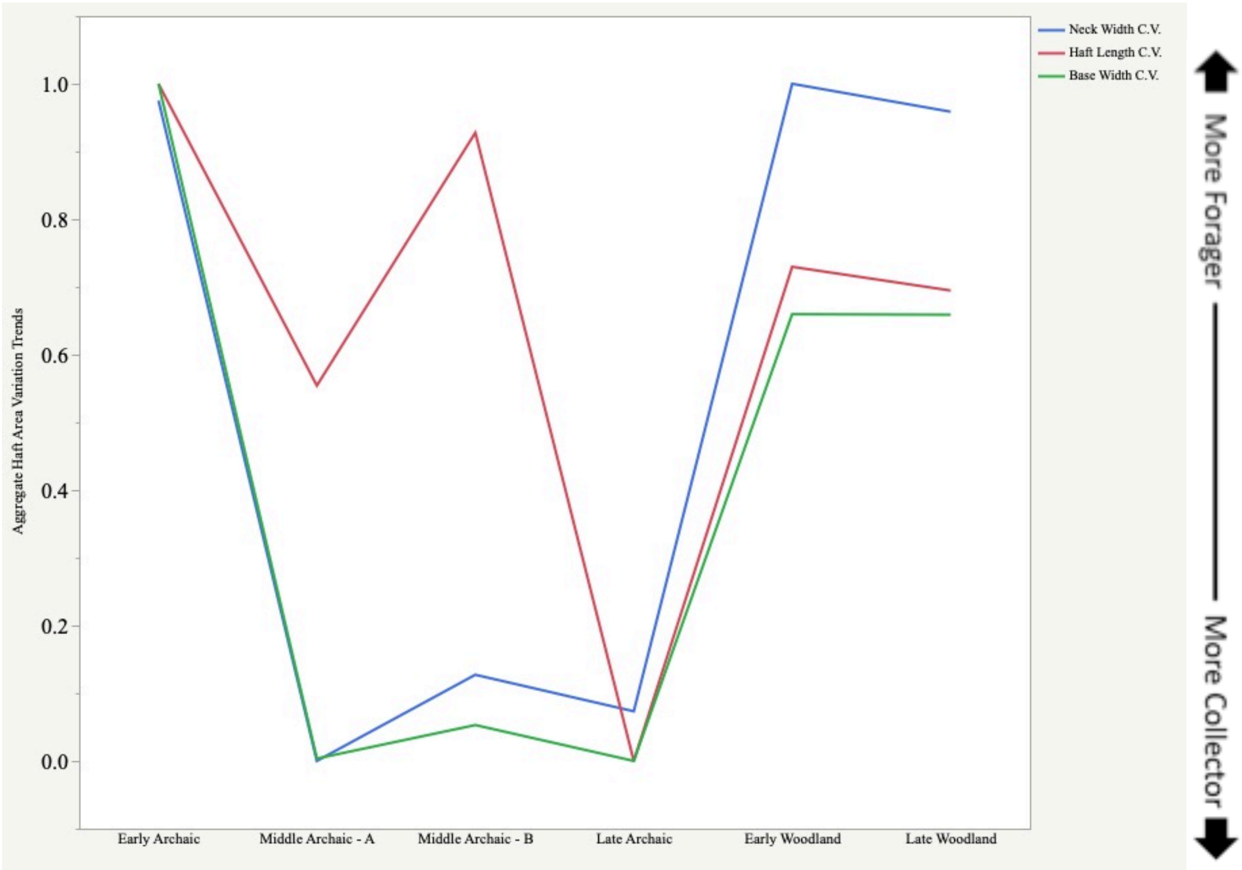

Figure 33. Haft Area Metrics Variation by Time Period (Low Range=Forager, High Range=Collector).

Stem-to-Length Ratio

Stem-to-Length Ratio is being examined because Kuhn (1989) argued that Forager systems are likely to use tools to exhaustion, leading to a greater stem-to-length ratio. Collector systems are likely to replace tools before exhaustion leading to a lower stem-to-length ratio. Decreases in stem-to-length ratios suggest a shift to more of a Collector and less of a Forager strategy. Additionally, Bousman (1994) proposed that expedient repair, rework in the haft for example, represents a Forager lifestyle, whereas discarded or unreworked broken points are evidence of a Collector lifeway.

Stem-to-length ratio was calculated by subtracting the haft length - equivalent to stem length in this assemblage - from total length, then the two whole numbers were divided by the greatest common divisor to provide the simplified ratio. The ratio increased greatly from the Early Archaic throughout the Middle Archaic with a leveling off effect seen beginning during the Late Archaic, and into the Early Woodland, plateauing at a relatively low level into the Late Woodland. Standard error among these metrics is considerable during the Early and Middle Archaic, however the error ranges decrease over time. All periods show overlapping ranges, however the Woodland data displays less variability (Figure 37). Thus, using the stem-to-length ratio to examine tool use intensity, we might conclude that Forager-focused activity decreased throughout the Archaic, exhibiting a steadily more Collector-centered path. This trend eventually leads to a steady plateau of probable Collector system activity during the Woodland Period.

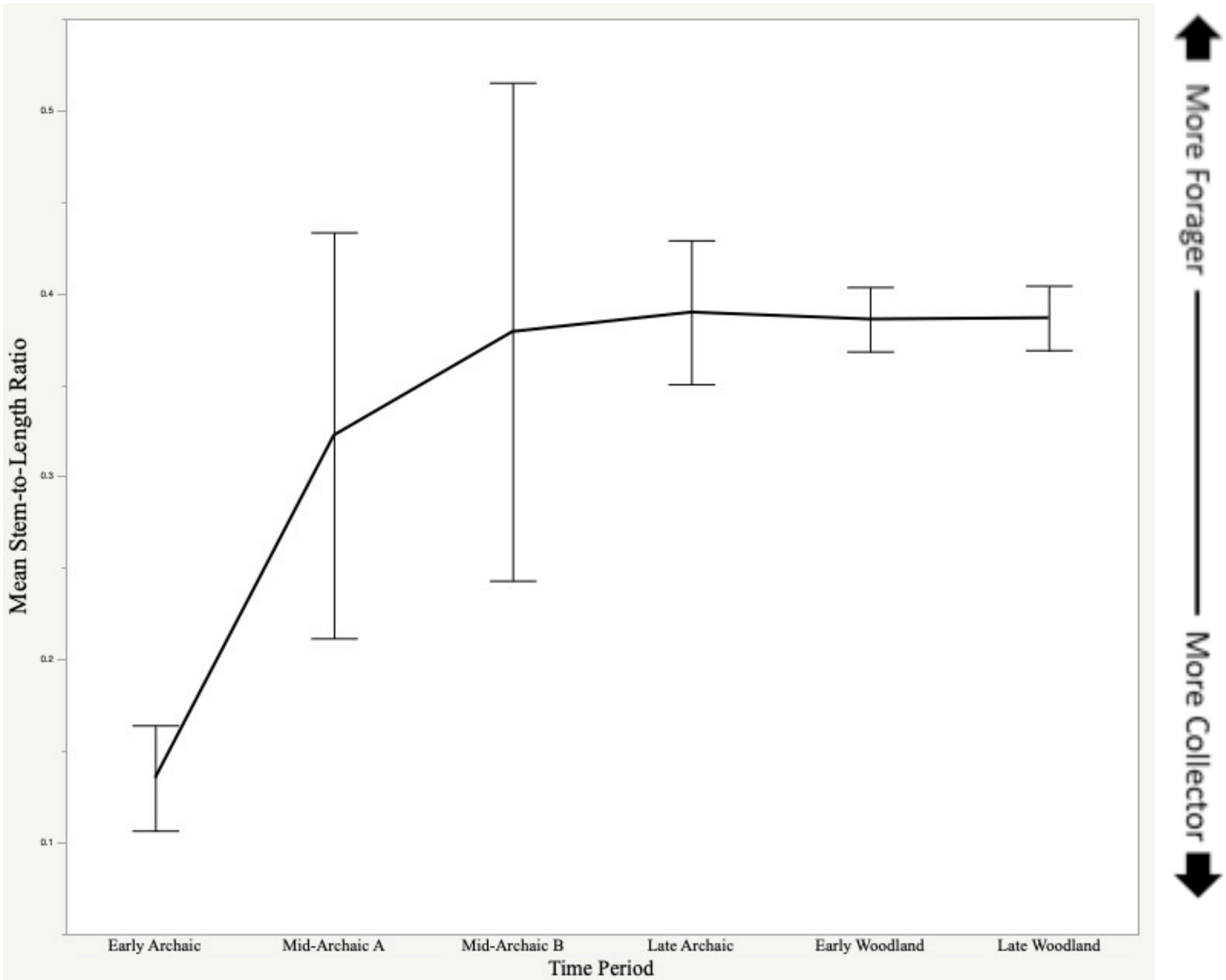

Figure 34. Stem-to-Length Ratio by Time Period.

Mean Maximum Thickness

Mean maximum thickness is being examined because Bousman (1994) posited that Forager systems are likely to invest less energy in the manufacture of tools and weapons in order to save time, whereas Collector systems would maximize resources by investing greater energy in point manufacture and rework. This investment can be exemplified by thinning during manufacture and rework.

Maximum Thickness for the point specimens was recorded as a mean of 10.6mm for Early Archaic with a wide degree of error. Subsequent periods exhibited much narrower error brackets. Periods 2 (8.2mm), 3 (8.1mm), and 4 (8mm) gradually decreased, before an increase to 8.5mm in Early Woodland/Delaware A. Late Woodland/Delaware B mean max thickness was recorded as 8.4mm (Figure 38). Thus, using the max thickness variable to examine energy investment – or lack thereof – in point manufacture and rework, we might conclude that from the Early Archaic through the end of the Woodland Period spear point thickness variation fluctuated between Forager and Collector strategy realms during each time period until leveling off in a somewhat greater, possibly Forager-indicative thickness during the Woodland.

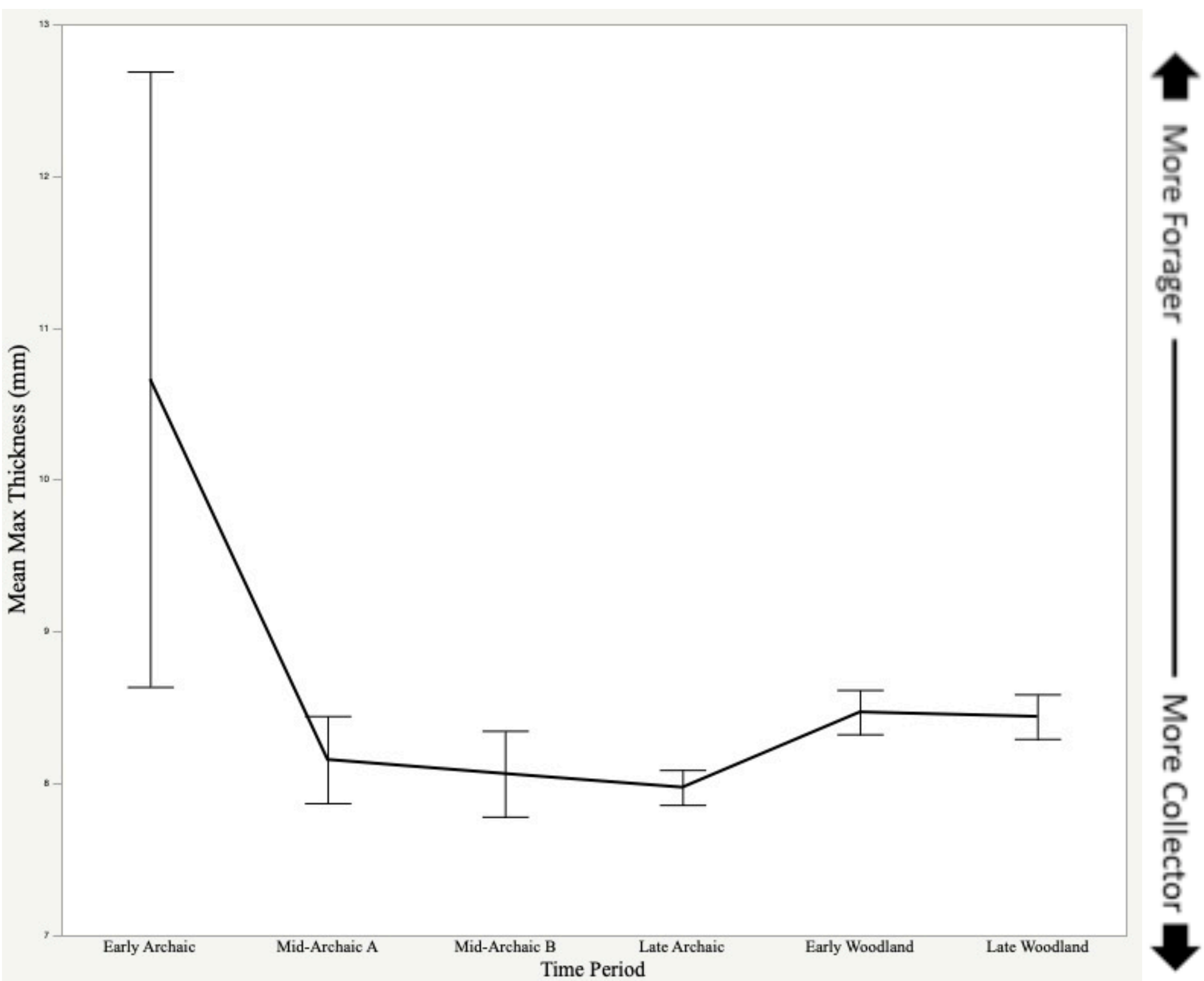

Figure 35. Mean Max Thickness (mm) by Time Period.

Percentage of Incomplete Points

The percentage of incomplete points (those less than 80% complete) is being examined because Bousman (1994) posited that Forager systems are likely to invest more energy into expedient tool repair during use, resulting in fewer broken points. In contrast, Collector systems are likely to display less regard for repair and rework and a corresponding greater percentage of incomplete specimens. Thus, increases in the percentage of broken, incomplete points may suggest a shift to more of a Collector and less of a Forager strategy.

The percentage of complete points peaked during the Early Archaic at about 80% and dropped to 50% then a low of 40% during the subsequent to periods respectively. The percentage of complete points was notably stable at between 50-55% with a slight increasing trend throughout the Late Archaic and Woodland Periods with steady error margins. Confidence margins remained overlapping throughout all time periods (Figure 39). Using the percentage of incomplete points variable to examine the contrast between more common discard of broken points versus expedient repair or broken points, we might conclude that there was a shift toward Collector behavior as the Early and Middle Archaic periods progressed. This was followed by a slow and gradual shift in the direction of more Forager behaviors during the Late Archaic and throughout the Woodland. This inference is tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

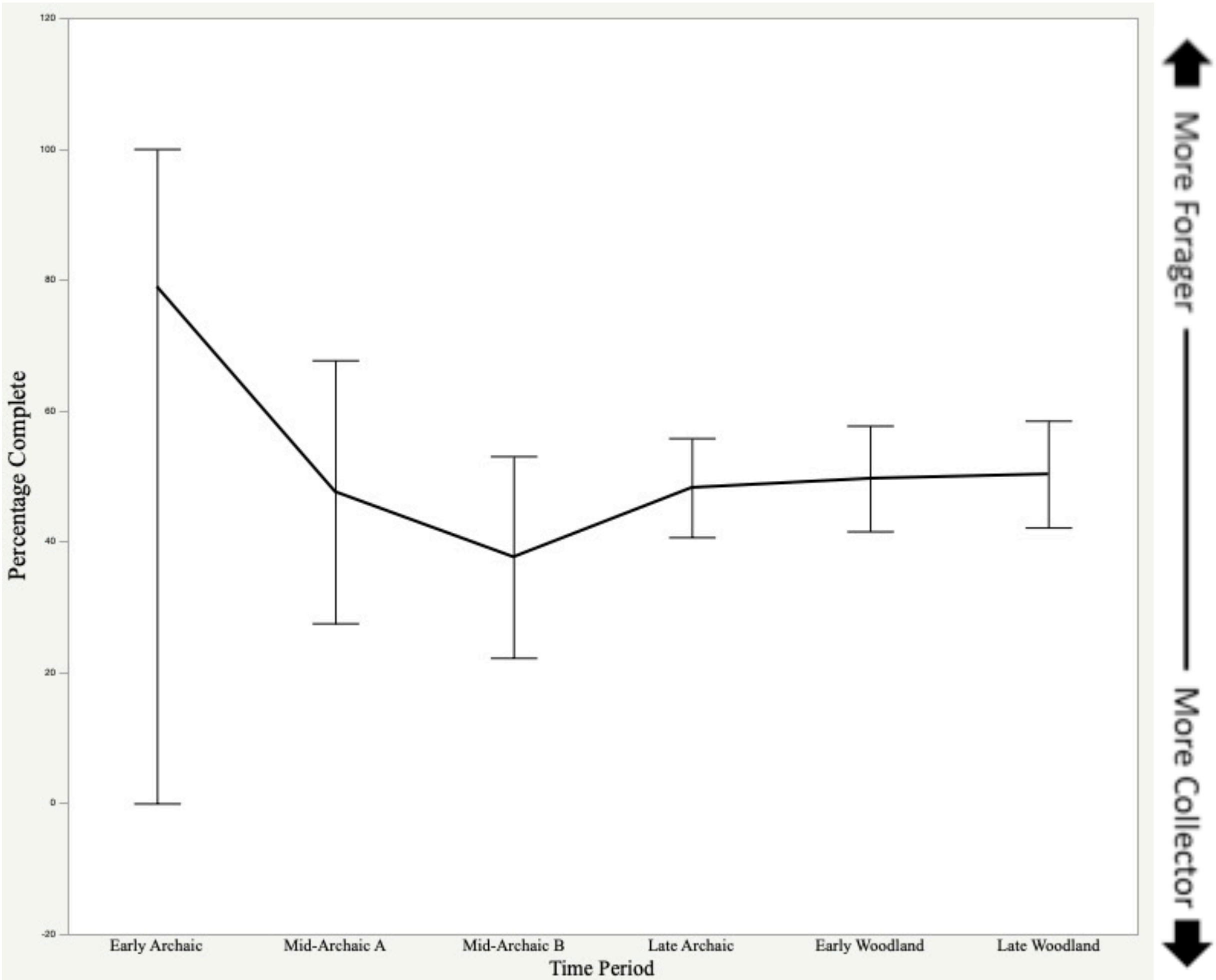

Figure 36. Percentage of Complete Points by Time Period.

Mean Index of Invasiveness Score

The index of invasiveness (degree of rework intensity) is being examined because Kuhn (1989) argued that Forager systems are likely to use tools to exhaustion, leading to a greater reworking. Collector systems are likely to replace tools before exhaustion leading to less reworking. Decreases in the intensity of rework suggest a shift to more of a Collector and less of a Forager strategy.

The mean index of invasiveness score exhibited a large degree of overlapping error from Middle Archaic/Grove B/Tom's Brook through all subsequent time periods. The Early Archaic exhibited a high flaking invasiveness score, which dropped sharply to the Middle Archaic. From that point in time the general trend was for a very gradual and subtle increase in invasiveness scores for each succeeding time period. The Woodland period appears to show a slight decrease in the intensity of rework when compared to the Late Archaic (Figure 40). Thus, using the index of invasiveness variable to examine the intensity and extensiveness of rework, we could conclude that a distinct shift toward more Collector-style point maintenance is observed at the Early-to-Middle Archaic transition, followed by a very slight shift back in the direction of foraging. This inference is tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

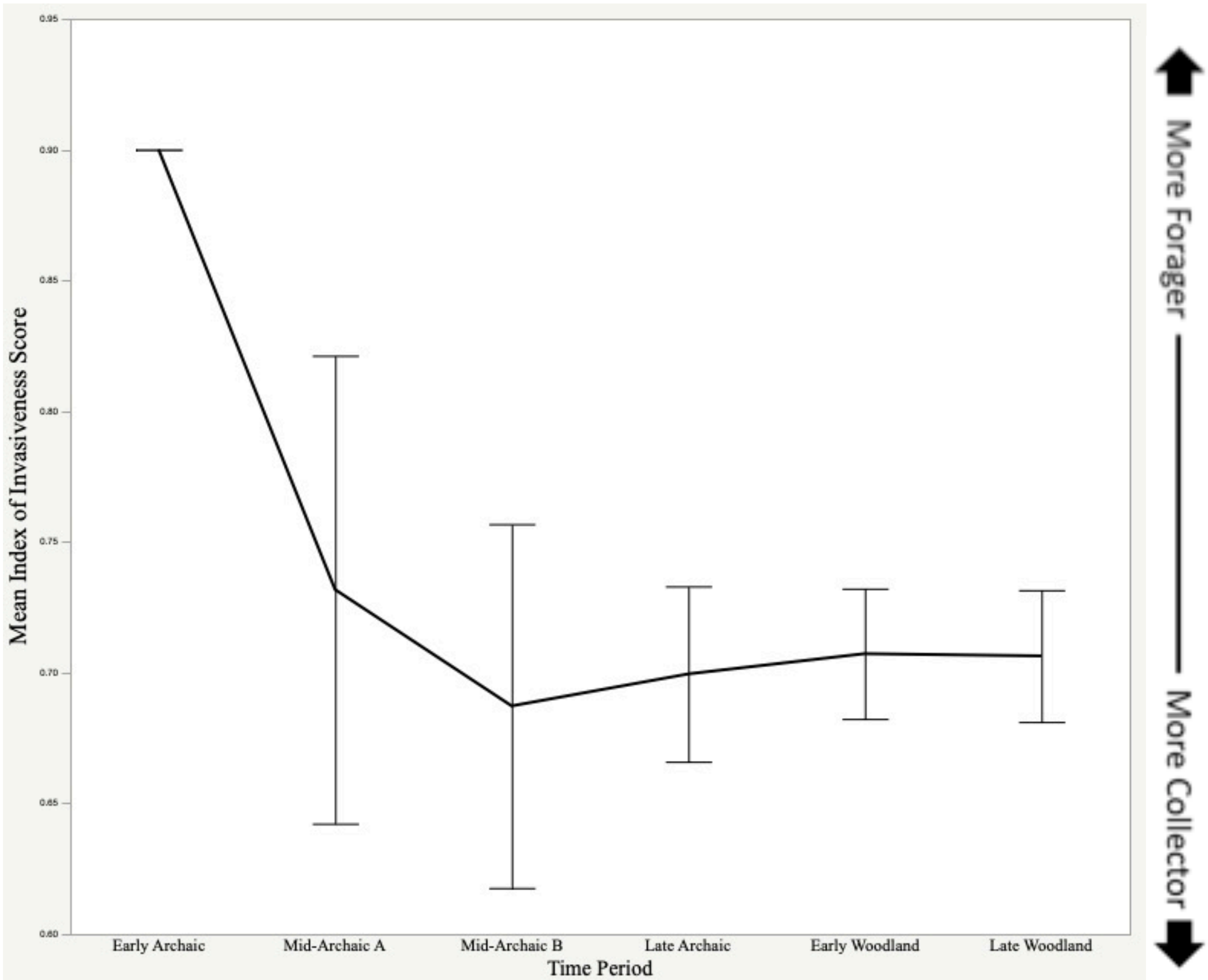

Figure 37. Mean Index of Invasiveness by Time Period.

Percentage of Rework

The presence or absence of rework is being examined because Kuhn (1989) argued that Forager systems are likely to use tools to exhaustion, leading to an increased prevalence of rework. Collector systems are likely to replace tools before exhaustion leading to a lower percentage of rework. Decreases in this percentage suggest a shift to more of a Collector and less of a Forager strategy. Furthermore, Bousman (1994) proposed that discarded or unreworked broken points are evidence of a Collector lifeway.

The percentage of rework present increased from the earliest to the latest time period with a steady upward trend observed during the Archaic and Woodland Periods. Early Archaic exhibited 25.3% rework, which increased to 32.2%, 42.5%, and 46.064% in Periods 2, 3, and 4. Early Woodland/Delaware A rose to 56.9% and Late Woodland/Delaware B exhibited 57.3% rework (Figure 41). By utilizing the rework percentage variable to examine maintenance energy investment, we might conclude that the increase in rework over time is indicative of steadily increasing Forager behavior over time. This inference is tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

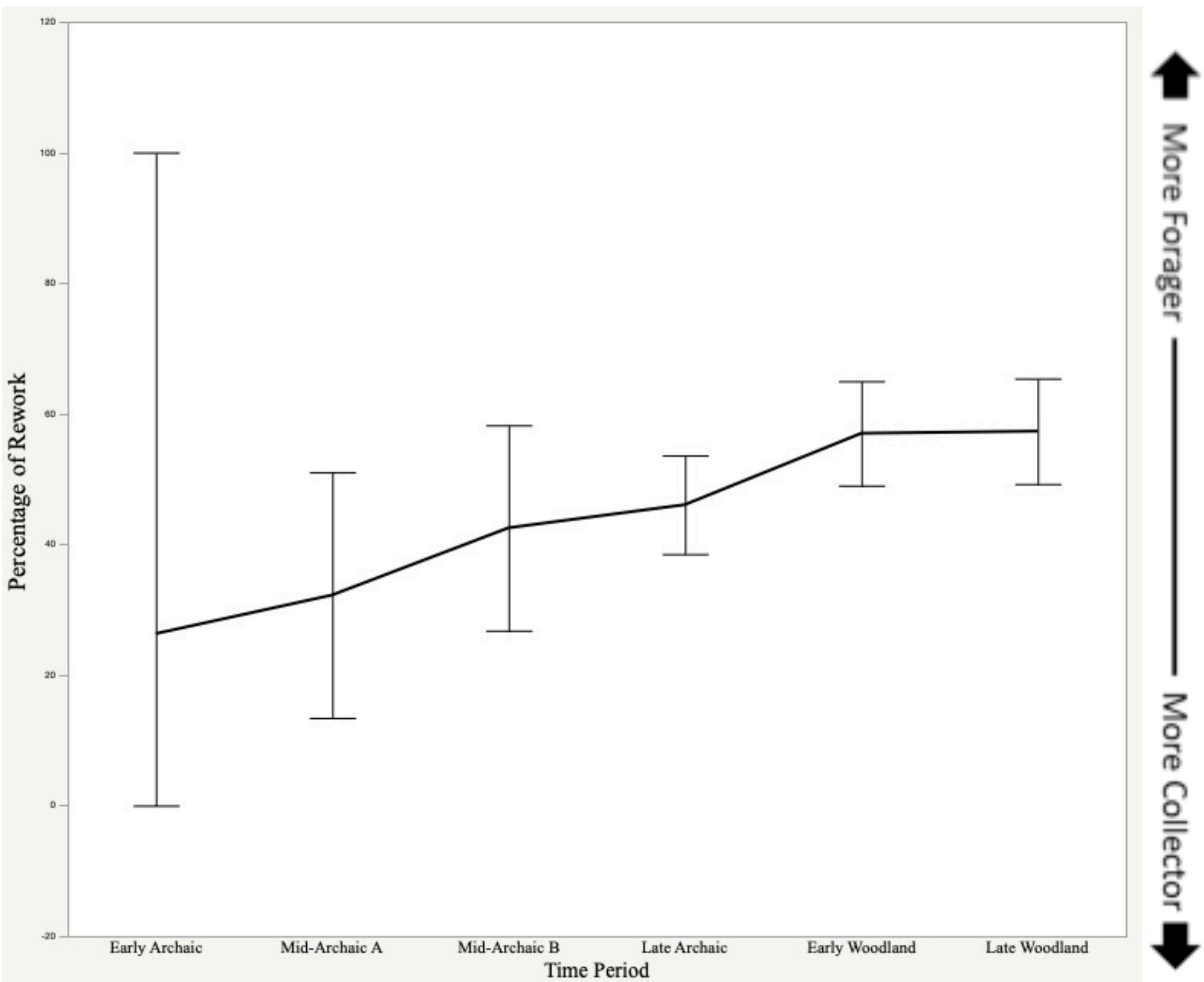

Figure 38. Rework Percentage by Time Period.

Percentage of Heat Treatment

Heat Treatment is being examined because Bousman (1994) proposed that Forager systems are likely to invest less energy in tool manufacture. In contrast, Collector systems are more likely to invest greater energy and utilize more formal technology. Thus, increases in the percentage of heat treatment may suggest a shift to more of a Collector and less of a Forager strategy and vice versa.

The percentage of heat treatment for Early Archaic was 0. Middle Archaic/Grove B/Tom's Brook exhibited 6.7%. Middle Archaic/Grove B/Caudill increased to 9.5% and Late Archaic/Grove C saw a leap to 12.3%. This steady upsurge during the Archaic was not continued during the Early Woodland/Delaware A, which reverted to 9.9%, and the Late Woodland/Delaware B was measured at 10.1% (Figure 42). Thus, using the percentage of heat treatment to examine energy investment in point manufacture, we might conclude that the Middle Archaic was becoming increasingly less Forager styled, peaking during the Late Archaic. This period saw an apex in heat-treatment application potentially indicative of a Collector-emphasized adaptation. This was preceded and succeeded by what may have been a more modest Collector lifeway or perhaps a wide variety of differing subsistence strategies during both the Middle Archaic and Woodland Periods. These inferences are tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

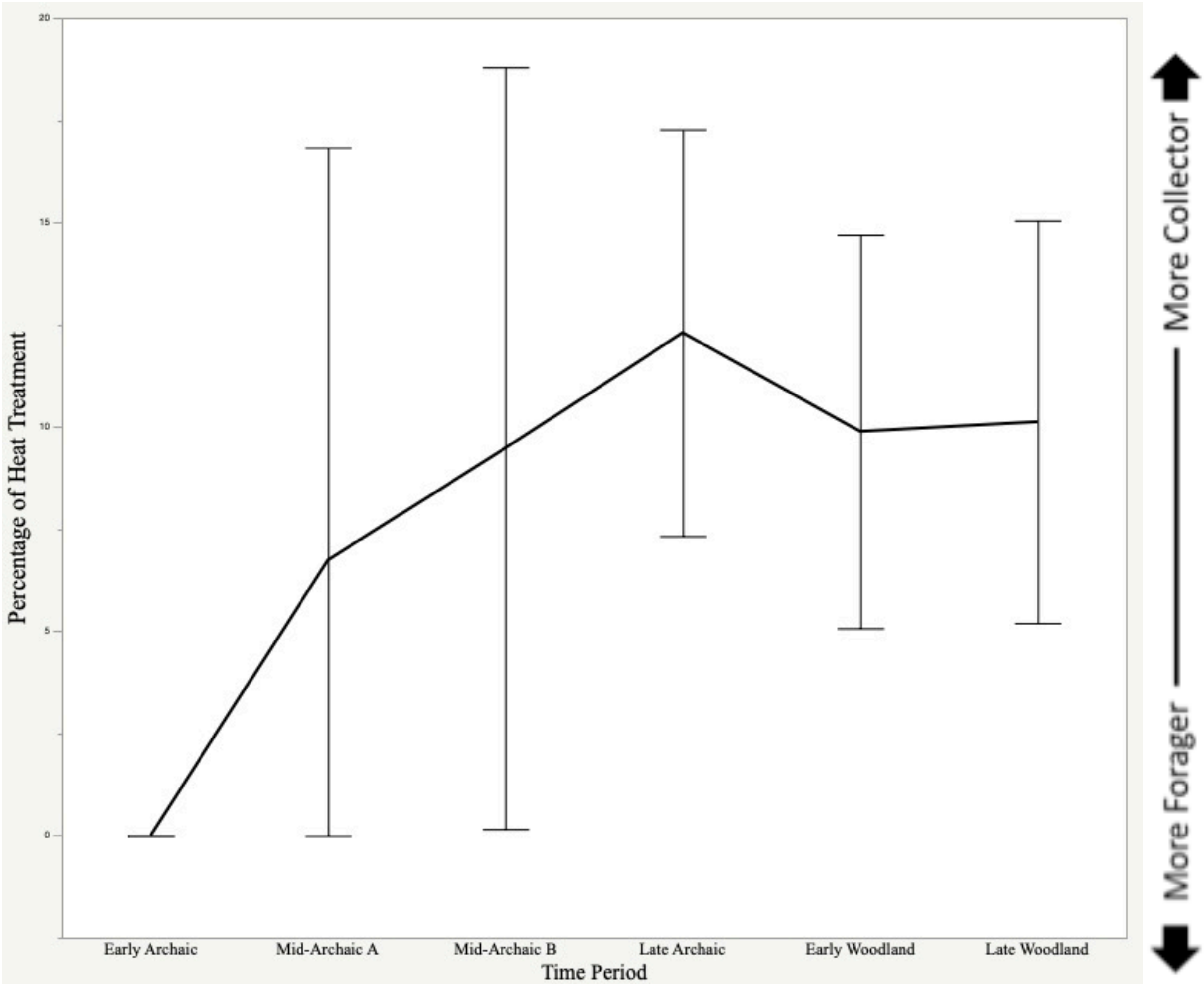

Figure 39. Heat Treatment Percentage by Time Period.

Percentage of Cortex

The presence or absence of cortex is being examined because Bousman (1994) proposed that Forager systems are likely to invest less energy in tool manufacture by utilizing informal flake blank technology. Evidence for this would include the presence of cortex. In contrast, Collector systems are more likely to invest greater energy and utilize more formal biface blank technology. This approach would remove most, if not all cortex from points during manufacture.

Thus, increases in the percentage of cortex present may signal a shift to more of a Forager and less of a Collector strategy and vice versa.

Error bars for all time periods are heavily overlapping. The percentage of cortex for Early Archaic was 0. The Middle and Late Archaic time periods exhibit consecutive fluctuations in the presence of cortex with a spike to just below 5% during the Late Archaic/Grove C/Lawrence Phase. This high point was followed by a modest drop off in cortex to about 3% throughout the Woodland Period (Figure 43).

Relying on the percentage of artifacts with cortex present to examine energy investment in point manufacture, we might conclude that the Early Archaic saw a peak in Forager behavior followed by a gradual downward trend toward a possibly less Foraging-reliant approach during the Late Archaic and Woodland Periods. This inference is tempered by the high degree of standard error overlap across all periods, lessening the significance of the overall trend.

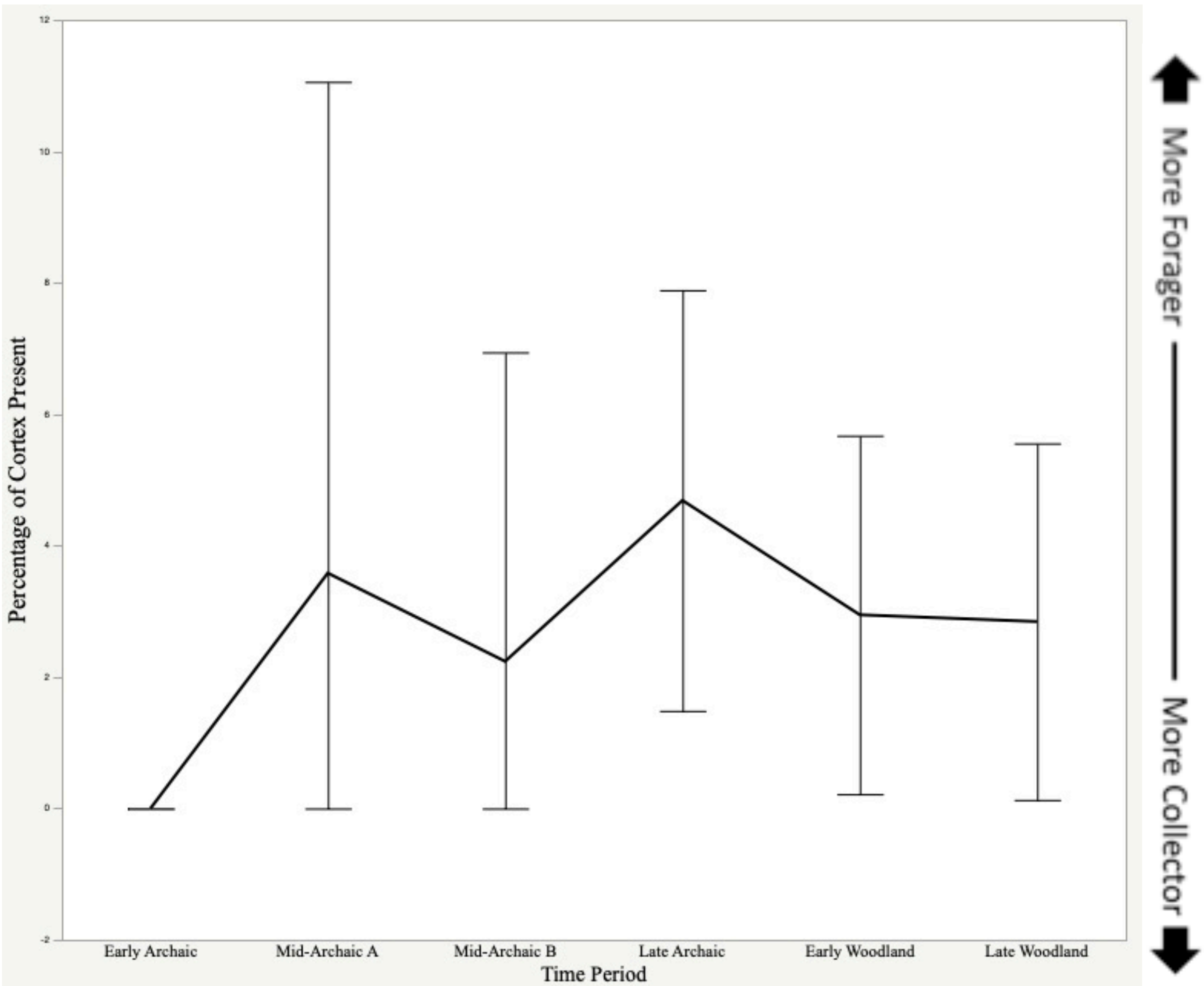

Figure 40. Percentage of Cortex Present by Time Period.

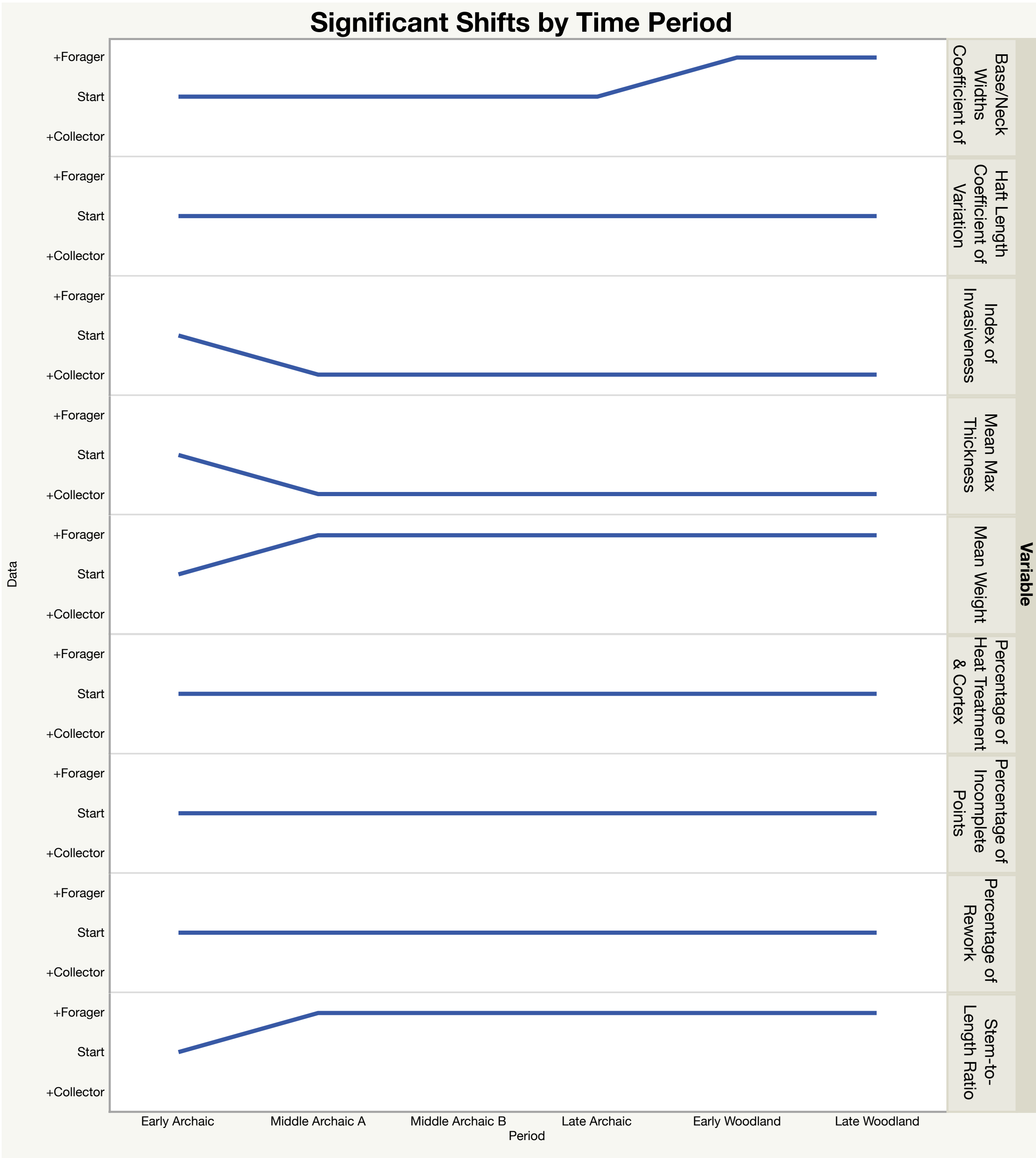

Figure 41. Statistically Significant Forager vs. Collector Shifts by Time Period presenting no overlap in error bars.

Statistical changes between time periods that did not exhibit overlapping error bars provided the most significant and reliable observable changes in each variable. These significant shifts are presented in Figure 44, with an indication of the interpretive direction – more forager or more collector – signaled by the data. There were fewer significant changes than expected; however some variables that shifted coincidentally in the same time period were neck and base widths – both indicators of haft standardization – that shifted in a forager-trending direction from the Late Archaic to the Woodland. Haft length coefficient of variation – another haft standardization metric – showed no statistically significant changes. The index of invasiveness scoring and mean maximum thickness metrics both shifted in a collector-trending direction from the Early Archaic to the Middle Archaic/Tom's Brook Phase. These metrics showed no other significant shifts. Conversely, both mean weight and stem-to-length ratio exhibited a forager-trending shift from the Early Archaic to the Middle Archaic/Tom's Brook Phase. Similarly, these metrics showed no other significant shifts. No other variables exhibited statistically significant shifts toward either forager or collector-trending directions in any of the time periods.

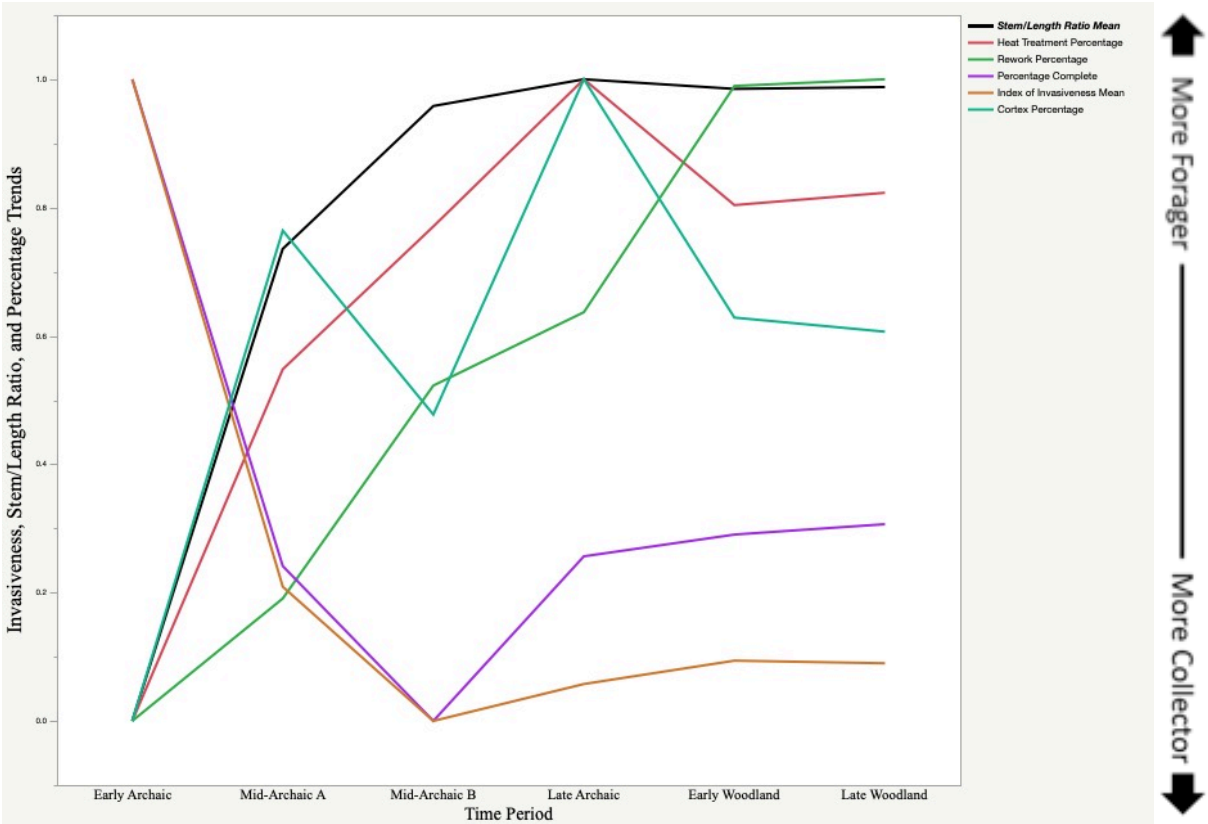

Figure 42. Aggregate Percentages, Stem/Length Ratio and Index of Invasiveness Trends by Time Period (Low Range=Collector, High Range=Forager)

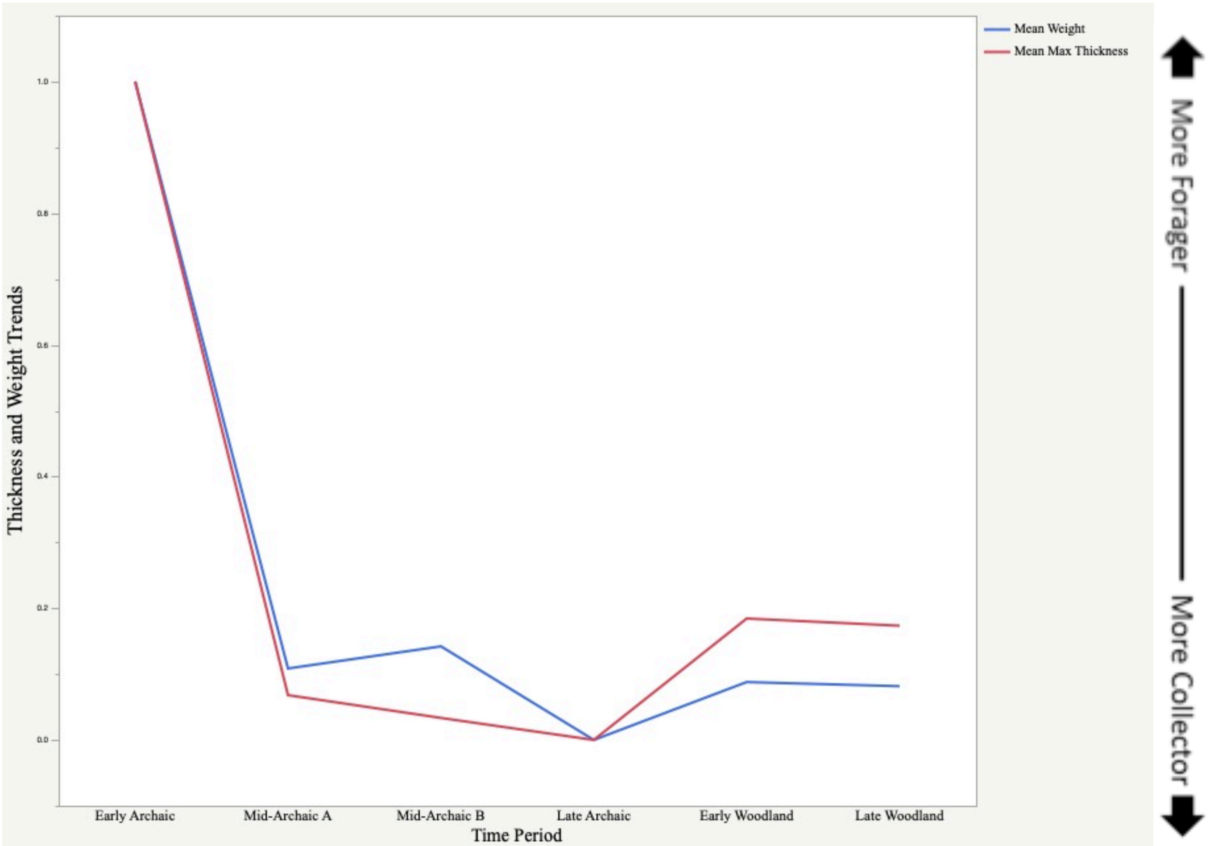

Figure 43. Aggregate Thickness and Weight Trends by Time Period (Low Range=Forager, High Range=Collector).

Bearing in mind that these aggregate trends do not meet statistical significance, there are some notable correlations. The percentage of specimens exhibiting rework and the stem-to-length ratio both present a steadily climbing upward trend (Fig. 45). Both were expected to show a steady decrease as evidence of a trend toward collector behavior. The percentages of heat treatment and cortex present also show a general, though fluctuating upward trend throughout the Archaic, however both decrease and then plateau during the Delaware A and Delaware B Foci respectively (Fig 45). Heat treatment was expected to steadily increase over time as evidence of greater energy investment in manufacture, but its erratic trend seems to peak during the Late Archaic. Cortex was expected to steadily decrease as evidence of more formalized biface blank technology, but surprisingly it only decreases during the Caudill Focus and then somewhat – though less - during the Woodland Period, never again reaching the lows of the Early Archaic.

The percentage of complete points and the mean index-of-invasiveness scores both decrease during the early and middle Archaic, after which the former exhibited a modest increase from the Late Archaic to the Woodland (Fig 45). Index of invasiveness plateaued at a low score during all time periods after the Middle Archaic. Both of these results are not unexpected and are consistent with a striking Middle Archaic shift toward Collector behavior followed by a Late Archaic and Woodland revival of some limited degree of Forager actions. Thickness and weight trended sharply down toward a more forager direction from the Early-to-Middle Archaic, followed by a continued slight trend in the same direction until the early Woodland, when both reversed trend slightly before plateauing (Fig 46). These trends contradict expectations that points would become heavier and bigger overall when transitioning toward a more collector lifeway, but with a reduced maximum thickness from the forager Early Archaic to the later eras, we do observe an expected trend on that metric.

Table 12. Summary of Statistically Significant and Aggregate Trend Results.

#	**Variable**	**Expectations (Based on hunting tech principals and existing archaeological paradigms)**	**Result**
1	Mean Weight	Gradual Increase over time.	Sharp statistically significant drop by M. Archaic followed by a plateau and a modest increase into the Woodland.
2	Percentage of Rework	Gradual Decrease over time.	Gradual Increase over time. Not statistically significant.
3	Percentage of Heat Treatment	Gradual Increase over time.	Erratic upward trend peaking during the Late Archaic before a modest decrease and plateau during the Woodland. Not statistically significant.

4	Percentage of Cortex	Gradual Decrease over time.	Increase to Tom's Brook, Decrease to Caudill, Increase to Late Archaic, Decrease to Delaware A, then slight decrease to Delaware B. Not statistically significant.
5	Percentage Complete	Gradual Decrease over time.	Rapid Decreases during Tom's Brook and Caudill Foci, followed by a modest increase during the Late Archaic then a Woodland plateau. Not statistically significant.
6	Stem-to-Length Ratio	Gradual Decrease over time.	Statistically significant increase by the Tom's Brook, followed by a less significant gradual Increase over time.
7	Index of Invasiveness	Gradual Decrease over time.	Sharp statistically significant decrease by Tom's Brook followed by modest decrease by Caudill, then a plateau.
8	Haft Area Standardization	Gradual Increase over time.	Two of three variables standardized by Tom's Brook; all haft variables standardized in a statistically significant shift by Late Archaic.
9	Maximum Thickness	Gradual Decrease over time.	Sharp statistically significant drop by M. Archaic followed by a plateau and a modest increase into the Woodland.

Chapter 7: Discussion and Interpretations

In this study I have asked when and in what manner the Archaic and Woodland inhabitants of the Lake Hudson region shifted from the residentially mobile Early Archaic Forager land-use strategy to the sedentary Late Woodland Collector strategy. Additionally, I have sought to determine the pace and inflection points of this change, and I have examined spearheads from Lake Hudson as my data source. This examination recorded data on the weight, thickness, haft area dimensions, rework index of invasiveness, stem-to-length ratio, and percentages of spear point completeness, rework, cortex, heat treatment based on the time periods of each point type. These metrics and observations were graphed over the six chronological culture-history divisions or phases within the Archaic and Woodland Periods. The observed trends were then compared to both Forager System Model and Collector System Model lithic hunting system technology principals (i.e. Less Attention to Hafting versus More Attention to Hafting) to determine how closely the spear points from each time period match the criteria for either a forager or a collector land-use system. The results were compared to current archaeological settlement and subsistence paradigms for the region.

Previous archaeological culture history studies in the northeastern part of Oklahoma have formed a consensus that there is evidence of a trend of steadily increasing residential sedentism from the early Archaic Period through the Woodland Period (Brooks 2012; Sabo, et al 1990; Vehik 1984; Wyckoff 1984). This evidence is largely in the form of burned-rock fire pits, storage pits, stone grinding basins, manos, metates, and structural remains such as post-molds increasingly observed in middle and late Archaic components trending toward the more settled and sedentary village life of the late Woodland Period. The underlying assumption based on previous regional culture-history was that the artifacts from the Early Archaic would exhibit traits consistent with a foraging system, and that some kind of observable gradation would be visible in the data from each subsequent cultural phase time period leading to strong correlations for collector behavior by the later part of the Woodland Period.

The results of the analysis match up to the subsistence and land-use strategy postulates as follows: The mean weight of the spear points from each time periods was examined with the expectation of observing a gradual increase over time signaling a slow shift from Maintainable (Forager strategy) weapons to more Reliable (Collector strategy) weapons. Weights revealed one unexpected, but statistically significant decrease from the Early to Middle Archaic a statistically not significant and minor gradual trend upward into the Woodland. The significant change in this case is contrary to expectations and the remainder of the data is ambiguous when viewed in isolation.

Another aspect of this investigation focuses on the supposition that a greater degree of maintainable weapons will be indicated by spear points reworked in the haft, while a greater degree of reliable weapons will be indicated by discarded, unrepaired spear points. By examining trends in Stem-to-Length ratio, percentage of rework, and the rework index of invasiveness, the data informs on rework patterns. Based on stem-to-length ratios increasing with statistical significance during the Tom's Brook Focus followed by a not statistically significant continuing upward trend, we might conclude that the Early Archaic to Middle Archaic transition witnessed a notable increase in Forager behavior, which may have persisted through all remaining periods. Clearly, this is in contrast to expectations and it is supported by the percentage of rework data that gradually increased through all time periods – though not in a statistically significant way.

We might conclude that the rework datasets support an unexpected trend of increasingly Forager-minded inhabitants, particularly during the Tom's Brook Focus, however the indices of invasiveness exhibit an expected statistically significant decrease from the early to Middle Archaic, followed by statistically not significant decreasing trend from then onward. This meets the expectations of an overall decrease possessing some significance, but it is not conclusive when compared to the rework data as a whole. Thus the rework results conflict considerably, with the percentage of rework and the stem-to-length ratios offering some support to an increasingly Forager conclusion, at odds with the index of invasiveness results. Incorporating the final variable related to rework and repair – the percentage of complete spear points per time period – does not satisfactorily solve this interpretive deadlock. Complete spear point specimens were expected to diminish in percentage with each succeeding time period, and this was the case from the early through middle Archaic. However, this trend increased again during the Late Archaic before plateauing. None of the percentage of completion data provided observable statistically significant shifts. The cross-referenced rework/repair versus broken/discarded and data and trends are inconclusive.

The percentage of heat treatment present and the mean maximum thickness were examined as measures of energy investment. The former variable exhibited an initial fluctuating upward trend that peaked during the Late Archaic before decreasing and plateauing. This trend data was not statistically significant can only be taken as tentative indication of the expected greater energy investment by a Collector system. The maximum thickness data is similarly only mildly supportive of expectations. Even cross-referenced, these data do not prove conclusive.

The percentage of cortex was examined as a measure of formal biface blank technology use versus informal flake blank technology. This statistical trend line alternated between chronological periods and was not statistically significant. It did not conform to expectations, nor did it convincingly provide an alternate trend. Examination of this variable did not prove conclusive.

Finally, Forager-style spear points are expected to exhibit less attention paid to hafting, while collector-style tools should exhibit greater attention to hafting. Greater focus on hafting elements can be observed through haft element standardization in size and dimensions. The coefficient of variation among neck-width, haft length, and base width was compared to examine haft design attention and standardization. Neck width and base width variables exhibited nearly matching decreases in variation – thus increases in standardization - by the Tom’s Brook Focus. Haft length was more highly variable until the Late Archaic, when that metric aligned statistically very closely with the other two. All three half metric variables exhibited nearly matching low variability during this statistically significant Late Archaic shift until the Delaware A Focus, at which time all three increased precipitously in variability. This would seem to indicate that the Middle and Late Archaic were increasingly highly haft-standardized period – indicating Collector-strategy behavior – but that contrary to expectations this behavior did not persist into the Woodland Period.

The post-analysis findings of this study indicate that none of the time periods in question exhibit increased Collector system criteria based on the lithic spear point analysis and hunting technology principals investigated. If this research had examined only mean weight and stem-to-length ratio an increasingly Forager trend might have been a reasonable conclusion. An examination of only the index of invasiveness data might have concluded that the trend was toward Collector behavior. However these variables provided a notable degree of debatable data, while the remaining analyses actually proved to be even more statistically ambiguous.

These interpretations did not match the anticipated findings, and the study results do not support conclusions that Early Archaic or Middle Archaic inhabitants of this region were any more or less mobile foragers or semi-sedentary collectors than Late Archaic or Woodland peoples based on their spear points alone. It is possible that definitive data trends are not present in the research sample due to the relative homogeneity of materials and the preponderance of stemmed morphological varieties dating to the Woodland Period. However, an alternative interpretation is that clear trends from forager behavior toward collector are not observable in the Yost Collection projectile point assemblage because either forager-system or collector-system dominant strategies dominated the Lake Hudson vicinity throughout most of the Archaic and much of the Woodland Periods.

Chapter 8: Conclusions and Future Research

This research was intended to further the study of prehistoric cultures in Northeast Oklahoma. I asked how and when the inhabitants of the Lake Hudson vicinity of the Grand River shifted from a forager strategy reflective of high residential mobility to a sedentary collector strategy; was this shift gradual or did it proceed rapidly, and what answers could lithic hunting technology reveal? My research focused on how hunting technology changed during the Archaic and Woodland periods (6,000 BCE to 1,300 CE), and how those changes reflect residential mobility and subsistence trends from that time. Previous archaeological research had focused on more direct evidence of mobility, land-use, and subsistence strategies such as structural remains and the presence of unwieldy artifacts such as manos and metates. My research utilized a theoretical model of cross-referenced indicators of either foraging or collecting land use and subsistence strategies to interpret metric analysis data from 522 Lake Hudson artifacts. The result that was expected was an observable, gradual shift from a non-sedentary foraging way of life in the Early Archaic to a fully sedentary agriculturally reliant system by the terminal Late Woodland. I anticipated that this shift would be evidenced by statistical indications of less forager-like, more collector-style design and curation trends. This expectation was based on established theories of changing subsistence and settlement strategies in the region. This analysis and interpretive model has not provided compelling hunting technology evidence of a shift from foraging to collecting land use and subsistence strategy.

There were several complicating factors that posed challenges within this analysis and some of these factors heavily impacted the study. As avocational artifact collectors, the Yosts intentionally collected with a bias toward artifacts that they thought might be diagnostic. This means that in some instances they potentially did not collect seemingly nondescript broken projectile-point tips or other separated point elements that might have been refitted or classified based on other characteristics. In site areas already transformed by varying degrees of modern disturbance, this practice may have left a great deal of data behind. Furthermore, the Yost Collection is a combination of artifacts from four sites and all specimens were collected from the surface. No detailed location information, spatial relationships, and almost no labeling or documentation was recorded when the collection was procured. This lack of specific assignable site-type information for groupings of points, and the lack of stratigraphic context are obstacles in effectively interpreting chronological time frames by which to examine change over time. This jumbling of artifacts from various contexts also compels the analyst to rely on established typology/culture history chronologies as a basis for examining change over time. This tactic relies on accurate archaeological data on the geographic and temporal distribution of each point type, and requires a correspondingly detailed series of culture history time periods by which to further subdivide the data.

The majority of often-cited projectile-point typologies that encompass present-day Oklahoma are several decades old or are published by researchers from other states with a focus on those states' culture history research needs. A reanalysis of the Yost collection assemblage with a focus on individual types rather than time-period aggregate groupings might yield new insights, however I highly support an update and revision of Oklahoma point typologies be produced first in order to gain the most accurate analytical results. Additionally, breaking the typologies down into sub-types (i.e. Gary 1, 2, and 3) would increase chronological periods and resolution. Alternatively, a reanalysis could focus on the temporal ranges of the three spear-point morphologies – and the omitted arrow point morphology – to produce chronological frames of reference. However, as can be observed in Figure 28, some morphological varieties span as little as two time periods while others persisted through five or six. Similarly complicating is the fact that stemmed points, which are present only during the final two periods within the study, account for the majority of the specimens. Smith points, of which there are only two specimens present, spanned all time periods within this study except the Late Woodland/Delaware B.

The Gary and Langtry stemmed point types were introduced to northeastern Oklahoma with the start of the Woodland Period and the Terminal Late Archaic, and they rapidly began to dominate Woodland hunting toolkits. Stemmed points have fewer morphological elements than notched points and therefore Gary and Langtry types may be produced more expediently at or near the hunting location if lithic resources are locally available. In the case of the project area, local Ozark lithic resources are abundant. Furthermore, the hafting of stemmed points can be readily accomplished by insertion and binding into a hollowed wood or bone dart foreshaft. This presents less complexity than using sinew to bind the multiple elements of notched point types placed within the groove of a foreshaft, and may be done in less time. The potential loss of penetrating power by presenting less cutting edge and having a generally somewhat thicker blade may be offset by more standardized manufacture and greater interchangeability.

Examining standardization by focusing on the hafting area as was done in this study can be very informative regarding the dart shaft size involved. This method in turn can inform on if the weapon system is strictly spear-thrower based or may use small enough shaft diameter to include bow and arrow possibilities. My study of the Yost Collection point assemblage haft areas appeared to show expected increasingly standardized haft areas during the Middle and Late Archaic. However that low variability turned into high variability among all three haft-area metrics with the advent of the Woodland Period. This unexpected statistical shift was most likely due to the introduction of stemmed projectile points to the existing variety of notched points.

This morphologically very different set of tool designs certainly produced a contrast and variance when compared metrically to surviving Archaic points. Further studies into haft standardization and variability should consider examining haft area elements within each unique morphology (i.e. corner-notched, basal-notched, stemmed, side-notched) rather than attempting to compare variance across designs. Additionally, standardization tests could also look at maximum thickness among points, as this sort of standard uniformity, if present, would also reflect easy and simple replacement of a part of the weapon system.

Analysis of this assemblage could also be augmented by a more intensive attempt to determine the date of bow and arrow introduction to NE Oklahoma using the Yost Collection projectile point assemblage. This could be accomplished by measuring the artifacts for necessary bow and arrow technology hafting, weight, and flight characteristics such as those proposed by Evans (1961), Blitz (1988), and Engelbrecht (2015). Some projectile points within this assemblage may demonstrate characteristics suitable for hafting as dart points or arrowheads. Taking this further, one might compare point size, point thickness and neck width and other factors to speculate on the specific prey or pre-range that each point type was designed and employed against. This can inform on diet breadth, which is assumed to be high and probably increasing or at least stable across the study area.

As has been demonstrated, abundant high-quality tool-stone varieties, primarily Ozark cherts, were available in the study area and throughout northeastern Oklahoma. This makes research into precontact northeastern Oklahoma territoriality tough to approach from a purely lithics perspective. However, there is a possible avenue for future research in this vein. Tool stone sources in the region have been researched in detail. Though the dominant material in the assemblage is Reed Springs chert, there are a variety of other definable local materials that can be discerned with a more precise macroscopic analysis or using X-ray fluorescence. Leith (2011) has noted that Ozark lithics have were a common item in the toolkits of Woodland Periods Fourche Maline groups north of the Sans Bois Mountains in southeastern Oklahoma. This may represent evidence of trade and mutual influence between these cultural zones, much like the Late Woodland influences exerted on the study area by Caddoan groups to the southeast. Alternatively the interactions between Fourche Maline peoples and Woodland Ozark groups were not always peaceful, as shown by the mass grave at the McCutchan-McLaughlin site in Latimer County considered by some to be evidence of Ozark/Fourche Maline conflict (Brooks 1986). An examination and comparison of the exact Ozark source materials from these northern Fourche Maline inhabitants would be useful in determining if they were each primarily utilizing different Ozark stone sources.

A focus on known technological turning points may prove beneficial. There were two notable instances of change in regional hunting toolkits that may reflect cultural intrusions. The less promising of the two is the rapid introduction of stemmed points to northeastern Oklahoma during the Delaware A Focus. This shift is not typically interpreted as associated with migrating groups or bands, but it is worth examining. The more intriguing event was the incoming Hopewellian Cooper Focus during the Woodland and its associated Snyders-like Cooper corner-notched points. This focus exhibited unique hunting behaviors and technology relative to the surrounding Delaware A and B inhabitants, and deserves to be studied as a possible inflection point. I recommend that future research on the Yost collection data examine the change in variables from Late Archaic notched points to the Woodland stemmed morphological varieties. A second inflection point for statistical comparison may be the shift from those same stemmed points to the notched Cooper Focus points. What changes in local lithic source materials might be observable? This could also be done for pre and post arrow point introduction. The statistical breakdown may just need to be observed over smaller two or three period portions to reveal correlating trends.

It is worth nothing that the western Ozark Plateau and the Neosho and Grand River Drainage are areas of rich and nearly ubiquitous resources, which may muddy the results of any attempt to parse out collector or forager activities. Floral and faunal targets are spread throughout the upland and bottomland communities. Water sources are plentiful. Lithic sources are high quality and abundant. The region is so well endowed that it simply may not lend itself well to the sort of subsistence examination proposed within this research. Conversely, a larger sample size of artifacts from several sites – preferably a mix of base camp and logistical activity sites – might be just what is needed to shrink statistical error when comparing temporal periods.

My previous observations on the complicating factors involved in working with assemblages collected by avocationalists and enthusiastic private individuals are not a condemnation of such collaboration. Archaeologists simply cannot be present for every discovery, and private individuals wanting to learn more about their collections – and to share artifacts and information cooperatively – should be encouraged. Interactions like this provide opportunities for outreach and education, which are potentially as valuable for archaeological preservation as are laws and regulations that protect and defend the archaeological record from the actions of collectors. The Yost family collected artifacts for many decades from site areas – some of which may now be inundated by Lake Hudson – and have thus preserved some valuable data for professional analysis. Their donation of this material to the Oklahoma Archaeological Survey is a positive example of cooperation, and their contribution has made further research such as this possible.

Additional archaeological research into hunting toolkits may prove informative on the evolving subject of Archaic and Woodland residential versus logistical mobility, sedentism, and even incipient agriculture in northeastern Oklahoma and beyond. It is my desire that future archaeological researchers continue to emphasize the information potential of spear and arrow points and the interpretive models described herein when examining questions of changing prehistoric cultural and technological strategies.

References

Albert, Lois E.

1981 *Ferndale Bog and Natural Lake: Five Thousand Years of Environmental Change in Southeastern Oklahoma.* Oklahoma Archeological Survey, Studies in Oklahoma's Past 7, Norman.

Albert and Wyckoff

1984 *Oklahoma Environments: Past and Present.* Prehistory of Oklahoma. Robert E. Bell, Ed., Academic Press, Inc., New York, pp. 1-43.

Andrefsky Jr, William

1994 Raw-Material Availability and the Organization of Technology. *American Antiquity.* Vol. 59, No. 1, pp. 21-34.

2005 *Lithics: Macroscopic Approaches to Analysis, 2nd Ed.,* Cambridge University Press.

2009 The Analysis of stone Tool Procurement, Production, and Maintenance. *Journal of Archaeological Research.* Vol. 17, No. 1, pp. 65-103.

2010 Human Land Use Strategies and Projectile Point Damage, Resharpening and Discard Patterns. *Human Evolution.* Vol. 25, No. 1-2, pp. 13-30.

Adair, Mary J.

1988 *Prehistoric Agriculture in the Central Plains.* University of Kansas Publications in Anthropology, Vol. 18, Lawrence.

Adair, Mary J., and Drass, Richard R.

2011 Patterns of Plant Use in the Prehistoric Central and Southern Plains. In *The Subsistence Economies of Indigenous North American Societies: A Handbook,* Bruce D. Smith, Ed., Smithsonian Institution Scholarly Press, Washington D.C.

Baerreis, David A.

1951 The Preceramic Horizons of Northeastern Oklahoma. *Anthropological Papers*, No. 6, Museum of Anthropology, University of Michigan.

Baerreis, David A. and Freeman, Joan E.

1959 A Report on a Bluff Shelter in Northeastern Oklahoma (D1-47). *Archives of Archaeology*, No. 1, Society for American Archaeology and the University of Wisconsin Press.

Baerreis, David A., Joan E. Freeman, and James V. Wright

1958 Contracting Stem Projectile Points in Eastern OK. *Bulletin of the Oklahoma Anthropological Society* 6:61-86. Oklahoma City.

Bamforth, Douglas B., and Bleed, Peter

1997 Technology, Flaked Stone Technology, and Risk. *Archeological papers of the American Anthropological Association.* Vol. 7 (1), P. 109.

Banks, Larry D.

1984 *Lithic Resources and Quarries.* Prehistory of Oklahoma. Robert E. Bell, Ed., Academic Press, Inc., New York, pp. 65-95.

1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, The Southern Plains, and Adjacent Southwest*. Oklahoma Anthropological Society, Memoir 4, Norman.

Bell, Robert E.

1958 *Guide to the Identification of Certain American Indian Projectile Points*. Special Bulletin No. 1, Oklahoma Anthropological Society, Oklahoma City.

1960 *Guide to the Identification of Certain American Indian Projectile Points*. Special Bulletin No. 2, Oklahoma Anthropological Society, Oklahoma City.

Bell, R.E., and D.A. Baerreis

1951 A Survey of Oklahoma Archaeology. *Bulletin of the Texas Archeological and Paleontological Society* Vol. 22, pp. 7-100.

Binford, Lewis R.

1972 Contemporary model building: paradigms and the current state of Palaeolithic research. In *Models in archaeology,* edited by D.L. Clarke. Methuen, London, pp. 109-166.

1976 *Forty-Seven Trips: A case study in the character of some formation processes of the Archaeological Record.* Contributions to Anthropology: The Interior Peoples of Northern Alaska, edited by Edwin S. Hall, Archaeological Survey of Canada Paper, National Museum of Canada, Ottawa, No. 49, pp. 299-351.

1978a Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand. *American Antiquity,* Vol. 4, No. 3, pp. 330-361.

1978b Nunamiut Ethnoarchaeology. Perechon Press, New York.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research,* Vol. 35, No.3, pp. 255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity,* Vol. 45, No. 1, pp. 4-20.

1990 Mobility, Housing, and Environment: A Comparative Study. *Journal of Anthropological Research,* Vol. 46, No. 2, pp. 119-152.

Bleed, Peter
1986 The Optimal Design of Hunting Weapons: Maintainability and Reliability. *American Antiquity.* Vol. 51, No. 4, pp. 737-747.

Blitz, John H.
1988 Adoption of the Bow in Prehistoric North America. *North American Archaeologist,* Vol. 9, No. 2, pp. 123-145.

Boszhardt, Robert F.
2002 Contracting Stemmed: What's the Point? *Midcontinental Journal of Archaeology,* Vol. 27, No.1, pp. 35-67.

Bousman, B.
1994. Hunter-Gatherer Adaptations, Economic Risk and Tool Design. *Lithic Technology* Vol. 18, pp. 59–86.

Brooks, Robert L.
1986 *Resource Protection Planning Process for Management Region 3 Ozark Plateau and Cherokee Prairie.* Report Submitted to the State Historic Preservation Office, Oklahoma Historical Society, Oklahoma City.

2012 Implications for Early Agriculture in Northeastern Oklahoma: A Collection of Tools from Lakes Hudson, Mayes County, Oklahoma. *Oklahoma Anthropological Society Bulletin,* Vol. 60, pp. 31-56.

Cheshire, Joseph, and Kelly, Robert L.
2006 Projectile Point Shape and Durability: The Effect of Thickness: Length. *American Antiquity,* Vol. 71, No. 2, pp. 353-363.

Clarkson, Chris
2002 An Index of Invasiveness for the Measurement of Unifacial and Bifacial Retouch: A Theoretical, Experimental and Archaeological Verification. *Journal of Archaeological Science.* Vol. 29, pp. 65-75.

Cobb, Charles R.
2000 *From Quarry to Cornfield: The Political Economy of Mississippian Hoe Production.* University of Alabama Press, Tuscaloosa.

Close, Angela E.
2000 Reconstructing Movement in Prehistory. *Journal of Archaeological Method and Theory.* Vol. 7, No. 1, pp. 49-77.

Davis, Leslie B., and Reeves, Brian O. K., eds.
1990 *Hunters of the Recent Past.* Unwin Hyman, London.

Day, Grant, Wampler, Marc E., Holzhauser, Christina, and Bebee, John
2008 *Phase I Archaeological Investigations of Select Parcels Bordering Lake Hudson in Mayes County, Oklahoma.* Report submitted to the Grand River Dam Authority by AMEC Earth and Environmental, Jefferson City, MO.

Densmore, Julie A.
2007 A Detailed Analysis of the Variation in Morphology of the Gary Dart Point. *Lithic Technology,* Vol. 32, No. 1, pp. 7-16.

Dockall, John E.
1997 Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence. *Journal of Field Archaeology,* Vol. 24, No. 3, pp. 321-331.

Elston, Robert G.
2013 Selection, Planning and Convenience in Lithic Procurement. *North American Archaeologist.* Vol. 34(4), pp. 433-350.

Engelbrecht
2015 Interpreting Broken Arrow Points. *American Antiquity.* Vol. 80, No. 4, pp. 760-766.

Evans, Oren F.
1961 The Development of the Atlatl and the Bow. In *Bulletin of the Texas Archeological Society,* Vol. 30 for 1959, Austin.

Flenniken, J. Jeffrey, and Anan W. Raymond
1986 Morphological projectile point typology: replication experimentation and technological analysis. *American Antiquity,* Vol. 51, No. 3, pp. 603-614.

Fritz, Gayle J.
1986 *Prehistoric Ozark Agriculture: The University of Arkansas Rockshelter Collections*. University of North Carolina Collections. Unpublished Dissertation, Department of Anthropology, University of North Carolina, Chapel Hill.

1990 Multiple Pathways to Farming in Precontact Eastern North America. *Journal of World Prehistory,* Vol. 4, No. 4, pp. 387-431.

Galm, Jerry R.
1984 Arkansas Valley Caddoan Formative; The Wister and Fourche Maline Phases. In *Prehistory of Oklahoma* edited by R.E. Bell, pp. 199-220. Academic Press, New York.

Galm and Flynn
1978 The Cultural Sequences at the Scott (34Lf-11) and Wann (34Lf-27) Sites and Prehistory of the Wister Valley. *Research Series No. 3, Archaeological Research and Management Center.* University of Oklahoma, Norman.

Gifford, Charlotte and Odell, George H.
1999 Digging in Museums: WPA Archaeology in the Grand River Valley As Seen from the Duck Creek Site. In *Bulletin of the Oklahoma Anthropological Society.* Vol. 48, Richard R. Drass, Ed., Oklahoma Archaeological Survey, University of Oklahoma, Norman.

Gramly, Richard M.
1980 Raw Materials Source Areas and "Curated" Tool Assemblages. *American Antiquity.* Vol. 45, No. 4, pp. 823-833.

Hames, R. B. and Vickers, W. T.
1982 Optimal Diet Breadth Theory as a Model to Explain Variability in Amazonian Hunting. *American Ethnologist*, No. 9, pp. 358-378.

Howard, Calvin D.
1995 Projectile point and hafting design review. *North American Archaeologist,* Vol. 16.4, pp. 291-301.

Huckell, Bruce B.
1982 The Denver Elephant Project: A Report on Experimentation with Thrusting Spears. *Plains Anthropologist,* Vol. 27, No. 97. pp. 217-224.

Jefferies, Richard W.
1988 Archaic Period Research in Kentucky: Past Accomplishments and Future Directions. In *Paleo-indian and Archaic Research in Kentucky.* Edited by Charles D. Hockensmith, David Pollack, and Thomas N. Sanders, pp. 85-126, Kentucky Heritage Council, Frankfort Kentucky.

1990 A Technological and Functional Analysis of Middle Archaic Hafted Endscrapers from the Black Earth Site, Saline County, Illinois. *Midcontinental Journal of Archaeology,* Vol. 15, No.1, pp. 3-36.

2008 *Holocene Hunter-Gatherers of the Lower Ohio River Valley*. The University of Alabama Press, Tuscaloosa.

Jeske, Robert J.
1992 Energy Efficiency and Lithic Technology: An Upper Mississippian Example. *American Antiquity*, Vol. 57, No. 3, pp. 467-481.

Johnson, Ann M. and Johnson, Alfred E.
1998 *The Plains Woodland*. Archaeology on the Great Plains. W. Raymond Wood, Ed., University Press of Kansas, Lawrence, pp. 201-234.

Johnson, Jay K.
2008 The Utility of Production Trajectory Modeling As a Framework for Regional Analysis. In *Alternative Approaches to Lithic Analysis.* David O. Henry and

George H. Odell, Eds., Archaeological Papers of the American Anthropological Association, No. 1, pp. 119-138.

Johnson, K.
2006 Geomorphic Provinces and Geologic Formations. In *Historical Atlas of Oklahoma,* 4th ed., by Charles Robert Goins and Danney Goble, pp. 4-9. University of Oklahoma Press, Norman.

Justice, Noel D.
1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States: A Modern Survey and Reference.* Indiana University Press, Bloomington.

Kay, Marvin
1998 *The Central and Southern Plains Archaic*. Archaeology on the Great Plains. W. Raymond Wood, Ed., University Press of Kansas, Lawrence, pp. 173-200.

Kelly, Robert L.
1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research.* Vol. 39, No. 3, pp. 277-306.

1988 The Three Sides of a Biface. *American Antiquity,* Vol. 53, No. 4, pp. 717-734.

1992 Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology*, Vol. 21, pp. 43-66.

1995 Foraging and Mobility. In *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institution Press, Washington, D.C., pp. 111-160.

Knecht, H. (ed).
1997 *Projectile Technology*. Plenum Press, New York.

Kuhn, Steven L.
1989 Hunter-Gatherer Foraging Organization and Strategies of Artifact Replacement and Discard. In Experiments in Lithic Technology, ed. D. Amick and R. Mauldin, pp. 33–47, BAR International Series 528, Oxford.

1994 A Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity.* Vol. 59, No. 3, pp. 426-442.

Larson, M.L.
1997 Rethinking the Early Plains Archaic. *Changing Perspectives on the Archaic of the Northwestern Plains and Rocky Mountains.* University of South Dakota Press, Vermillion.

Latham, Mark A.
2007 *Cultural Resources Site Detection Survey at Camp Gruber Joint Maneuver Training Center – Heavy, Muskogee County, Oklahoma.* Report prepared for Oklahoma Army National Guard by Burns & McDonnell Engineering Company, Inc., Kansas City, Missouri.

Leith, Luther J.
2011 *A Re-conceptualization of the Fourche Maline Culture: The Woodland Period as a Transition in Eastern Oklahoma.* Doctoral Dissertation, University of Oklahoma, Norman.

2006 *The McCutchan-McLaughlin Site: A Stratigraphic Study of Material Culture Change and Possible Adoption of Horticulture.* Master's Thesis. University of Oklahoma, Norman.

Logan and Beck
1995 Woodland Period Research. In *The Archaeology of Kansas: A Guide to Future Research, Part 2,* by Brad Logan and William E. Banks, pp. 3-44. University of Kansas, Museum of Anthropology, Project Report Series No. 86 (draft).

Marshall, Yvonne
2006 Adopting a Sedentary Lifeway. *World Archaeology*. Vol 38, No. 2, pp. 153-163.

McGrath, K.C., J.H. Ray, and D. Benn
1998 *Phase II Testing of Sites 23GR539, 23GR600, and 23GR601, for the Sac River Truck Sewer, City of Springfield, Green County, Missouri: 1988.* CAR-734. Center for Archaeological Research, Southwest Missouri State University, Springfield.

Nassaney, Michael S. and Pyle, Kendra
1999 Adoption of the Bow and Arrow in Eastern North America: A View from Central Arkansas. *American Antiquity,* Vol. 64, No. 2, pp. 243-263.

Neal and Benefield
2001 *An Archeological Survey of the Dirty Creek Basin, Muskogee and McIntosh Counties, Oklahoma.* The University of Oklahoma, Oklahoma Archeological Survey, Archeological Resources Survey Report Number 44. Norman, Oklahoma.

Nelson, Margaret C.
1991 The Study of Technological Organization. *Archaeological Method and Theory.* Vol. 3, pp. 57-100.

O'Brien, Michael J.
Middle and Late Woodland Subsistence and Ceramic Technology in the Central Mississippi River Valley: Selected Studies from the Burkemper Site, Lincoln County, Missouri. Illinois State Museum, Reports of Investigations No. 52.

O'Brien, M. J. and W. R. Wood
1998 *The Prehistory of Missouri.* University of Missouri Press, Columbia.

Odell, George H.
1981 The Mechanics of Use-Breakage of Stone Tools: Some Testable Hypotheses. *Journal of Field Archaeology,* Vol. 8, No. 2, pp. 197-209.

1985 Small Sites Archaeology and Use-Wear on Surface Collected Artifacts. *Midcontinental Journal of Archaeology,* Vol. 10, No. 1, pp. 21-48.

1994 Prehistoric Hafting and Mobility in the North American Midcontinent: Examples from Illinois. *Journal of Anthropological Archaeology,* Vol. 13, pp. 51-73.

1996 Stone Tools: Theoretical Insights into Human Prehistory. Ed. Plenum Press, New York.

1998 Investigating Correlates of Sedentism and Domestication in Prehistoric North America. *American Antiquity,* Vol. 63, No. 4, pp. 553-571.

2004 Lithic Analysis. Springer Science+Business Media, New York.

Parchami
2016 Weighted Descriptive Statistics. Electronic Document, https://cran.r-project.org/web/packages/Weighted.Desc.Stat/Weighted.Desc.Stat.pdf, accessed February , 2019.

Pargeter, Justin
2011 Assessing the Macrofracture Method for Identifying Stone Age hunting weaponry. *Journal of Archaeological Science,* Vol. 38, pp. 2882-2888.

Parry, William J., and Kelly, Robert L.
1987 Expedient Core Technology and Sedentism. *The Organization of Core Technology.* Johnson, Jay K. Ed., pp. 285-304.

Perino, Gregory
1968 *Guide to the Identification of Certain American Indian Projectile Points*. Special Bulletin No. 3, Oklahoma Anthropological Society, Oklahoma City.

Pitblado, Bonnie L.
2003 *Late Paleoindian Occupation of the Southern Rocky Mountains: Early Holocene Projectile Points and Land Use in the High Country*. University Press of Colorado, Boulder.

Polone, Dock, Wenland, Claude T., and Swafford, Bill G.
1972 *Soil Survey of Mayes County, Oklahoma.* US Department of Agriculture, Soil Conservation Service, Stillwater, Oklahoma.

Purrington, Burton L.

1971 The Prehistory of Delaware County, Oklahoma: Cultural Continuity and Change on the Western Ozark Periphery. University of Wisconsin Collections Unpublished Dissertation, Department of Anthropology, University of Wisconsin, Madison.

Railey, Jim A.

2010 Reduced Mobility of the Bow and Arrow? Another Look at "Expedient" Technologies and Sedentism. *American Antiquity,* Vol. 75, No. 2, pp. 259-286.

Ray, Jack H.

2007 *Ozarks Chipped-Stone Resources: A Guide to the Identification, Distribution, and Prehistoric Use of Cherts and other Siliceous Raw Materials*. Missouri Archaeological Society Special Publications No. 8.

Raymond, Anan.

1986 Experiments in the Function and Performance of the Weighted Atlatl. *World Archaeology,* Vol. 18, No. 2, pp. 153-177.

Reeves, Brian O.K.

1983 *Culture Change on the Northern Plains 1000 BC – AD 1000.* Alberta Culture.

Roberson, Glen

2009 Grand River Dam Authority. In *Encyclopedia of Oklahoma History and Culture,* edited by Diana Everett, Linda D. Wilson, Larry O'Dell, Jon D. May, pp.612-613. Oklahoma Historical Society, Oklahoma City.

Rondeau, Michael F.

1979 *Projectile Point Analysis for the Kahorsho Site: NA 10,937, Central Arizona.* Sacramento State University Collections. Unpublished Master's thesis, Department of Anthropology, Sacramento State University, Sacramento.

Sabo, George III, Ann M. Early, Jerome C. Rose, Barbara A. Burnett, Louis Vogele, Jr., and James P. Harcourt.

1990 *Human Adaptation in the Ozark-Ouachita Mountains.* Arkansas Archaeological Survey, Fayetteville. Final Report Submitted to the U.S. Army Corps of Engineers, Southwestern Division.

Sassaman, Kenneth E.

1992 Lithic Technology and the Hunter-Gatherer Sexual Division of Labor. *North American Archaeologist,* Vol. 13, No. 3, pp. 249-262.

Schambach, Frank F.
1982 An Outline of Fourche Maline Culture in Southwest Arkansas. *Arkansas Archaeology in Review,* edited by N. L. Trubowitz and M. D. Jeter, pp. 132-197. Arkansas Archaeological Survey, No. 125, Fayetteville.

1998 *Pre-Caddoan Cultures in the Trans-Mississippi South: A Beginning Sequence.* Arkansas Archaeological Survey Research Series 53, Fayetteville.

Sellet, Frederic
1993 Chaine Operatoire: The Concept and Its Applications. *Lithic Technology.* Vol. 18, No. 1/2. pp. 106-112.

Shott, Michael
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. *Journal of Anthropological Research,* Vol. 42, No.1, pp. 15-51.

1993 Spears, Darts and Arrows: Late Woodland Hunting Techniques in the Upper Ohio Valley. *American Antiquity,* Vol. 58, No. 3, pp. 425-443.

Smith, Bruce D.
1992 Rivers of Change: Essays on Early Agriculture in Eastern North America. Smithsonian Institution, Washington D.C.

Taylor, Walter W.
1964 Tethered nomadism and water territoriality: an hypothesis. *Acts of the 35th International Congress of Americanists*, pp. 197-203. Mexico City.

Titmus, Gene L. and Woods, James C.
1986 Experimental Study of Projectile Point Fracture Patterns. *Journal of California and Great Basin Anthropology,* Vol. 8, No. 1, pp. 37-49.

Torrence, R.
1983 Time Budgeting and Hunter-Gatherer Technology. In *HunterGatherer Economy in Prehistory: A European Perspective,* edited by G. Bailey, pp. 11-22. Cambridge University Press, Cambridge.

1989 Retooling: Towards a Behavioral Theory of Stone Tools. In *Time, Energy, and Stone Tools,* edited by R. Torrence, pp. 57-66. Cambridge University Press, Cambridge.

Turner, Ellen S., Hester, Thomas R. and McReynolds, Richard L.
2011 *Stone Artifacts of Texas Indians,* 3rd Ed., Taylor Trade Publishing, Plymouth.

Vanpool, Todd L.
2006 The Survival of Archaic Technology in an Agricultural World: How the Atatl and Dart Endured in the North American Southwest. *Kiva,* Vol. 71, No. 4, pp. 429-452.

Varien, Mark D.
1999 *Sedentism and Mobility in a Social Landscape: Mesa Verde and Beyond*. University of Arizona Press, Tucson.

Vehik, Susan C.
1984 *The Woodland Occupations.* Prehistory of Oklahoma. Robert E. Bell, Ed., Academic Press, Inc., New York, pp. 175-197.

Wyckoff, Don G.
1963 The Kerr Dam Site, a Stratified Site in the Markham Ferry Reservoir Area, Mayes County, Northeast Oklahoma. *Oklahoma River Basin Survey, Archaeological Site Report* No. 1.

1964 The Cultural Sequence at the Packard Site, Mayes County, Oklahoma. *Oklahoma River Basin Survey, Archaeological Site Report* No. 2.

1984 *The Foragers: Eastern Oklahoma.* Prehistory of Oklahoma. Robert E. Bell, Ed., Academic Press, Inc., New York, pp. 119-160.

Wyckoff, Don G., and Brooks, Robert L.
1983 Oklahoma Archaeology: A 1981 Perspective of the State's Archaeological Resources, Their Significance, Their Problems and Some *Report,* Number 16.

Wyckoff, Don G., Philip Robison, and Thomas P. Barr
1963 Markham Ferry Reservoir Archaeological Resources, Mayes County, Oklahoma. *Oklahoma River Basin Survey, General Survey Report* No. 1.

Young, Lisa C.
1994 Logistic Mobility and Expedient Technology: A Response to Sullivan. *Journal of Anthropological Research,* Vol. 50, No. 2, pp. 165-167.

Zeanah, David W., and Elston, Robert G.
2001 Testing a simple hypothesis concerning the resilience of dart point styles to hafting element repair. *Journal of California and Great Basin Anthropology,* Vol. 23, No. 1, pp. 93-124.

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
1	1	Corner	5	Lange	1	1	1	0	0	0	0		14.8	9.5		12.7	12.7		15.2	15.6	
2	2	Corner	5	Lange	0	1	1	0	1	1	1	0.7	16.5	8.6		13.3	13.3	34.4	21.2	23.2	15
3	3	Corner	5	Lange	1	1	1	0	0	0	0		21.1	9.4		15.2	15.2	46.4	23.6	24.4	19
4	4	Corner	5	Lange	1	1	1	0	0	1	1	0.7	24.8	11.7	44.9	20.5	20.5	37.8	22.2	23.1	18.6
5	5	Corner	5	Lange	1	1	1	0	0	0	0		24.3	11.3		14.9	14.9	40.4	24.6	29.2	16.5
6	6	Corner	5	Lange	0	1	1	0	0	0	0		10.2	8.4		12.8	12.8	38.8	15.4	13.6	
7	7	Corner	5	Lange	0	1	1	0	0	0	0		13	7.7		12.8	12.8	36.3	21.4	22	14.8
8	8	Corner	5	Lange	1	1	1	0	0	0	0		8.5	10.8		17.8	17.8		22	23.7	20.5
9	9	Corner	5	Lange	1	1	1	0	0	1	0		8.4	8.1		11.4	11.4		17	22.7	17.4
10	10	Corner	5	Lange	0	1	1	0	0	0	0		6.4	8.3		14.6	14.6		20.6	20.8	15.3
11	11	Corner	5	Lange	1	1	1	0	0	1	0		10	10.6		10.5	10.5	33.7	20	23.3	11
12	12	side	12	Ensor	1	1	1	0	0	0	1		13.8	9.1	49.6	7.2	9.6	33.7	19.8	11.5	9.8
13	13	side	12	Ensor	1	1	1	0	0	1	1	0.4	21.5	8.5		12.2	16		24.5	30	15.3
14	14	side	12	Ensor	0	1	1	0	0	0	1		19.8	7.6	60	12.8	15.2	33.3	19.2	23.8	10.4
15	15	side	12	Ensor	1	1	1	1	0	0	0		9.8	9.7		9.3	13.5	33.6	20.5	22.9	14.2
16	16	side	12	Ensor	1	1	1	0	0	0	0		14.4	9.9		11.2	14.1		19.3	27.2	10.8
17	17	side	12	Ensor	1	1	1	0	0	1	0		6.9	5.6		12.1	12.1		24.3	29	11.2

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
18	18	side	12	Ensor	1	1	1	1	0	0	0		10.6	8.2		11	14.9	45.2	26.6	29.8	11.9
19	19	side	12	Ensor	0	1	1	0	0	0	1		28.5	10.4	71.9	12.1	12.1	37.5	24.4	28.2	13.2
20	20	side	12	Ensor	0	1	1	0	0	1	0		7.5	5.1		9.1	9.1	30.2	15.8	16.3	12
21	21	side	12	Ensor	0	1	1	0	0	0	0		8.4	7.8		7.2	10.7	32.2	18.9	20.1	15.3
22	22	side	12	Ensor	0	1	1	0	0	0	1		10.7	7.3	42.2	11.7	12	30.9	21.8	25.7	10.3
23	23	side	12	Ensor	0	1	1	0	0	0	0		13.7	9.5		10.6	13	31.9	18.9	20	11.9
24	24	side	12	Ensor	0	1	1	1	0	0	0		7.9	9			11.3				9.3
25	25	side	12	Ensor	0	1	1	0	0	1	1	1	21.5	9.8	58.3	9.4	12.5	32.7	21.5	25	9.4
26	27	side	12	Ensor	1	1	1	1	0	0	0		23.9	10.2		15.4	15.4	36.4	24.4	27.5	14.9
27	28	side	12	Ensor	1	1	1	1	0	1	0		14.1	7		13	13.9	35.9	17.2	19.6	11.9
28	29	side	12	Ensor	0	1	1	1	0	0	1		13.4	8	49.5	7.7	12.3	29.3	19.2	22.2	7.6
29	30	side	12	Ensor	1	1	1	0	0	0	0		14.8	8.1		8	10.5	32.2	21.7	21.5	11.5
30	31	side	12	Ensor	0	1	1	0	0	1	1	0.8	20.2	10.6	45.2	11.7	14.6	38.8	23.7	25.9	16.5
31	32	side	12	Ensor	1	1	1	0	0	0	0		21.4	9.5		13.4	15.1	37.2	24.6	29.8	20.1
32	33	side	12	Ensor	1	1	1	0	0	0	0		8.9	9.3		8.1	11	33.9			13.6
33	34	side	12	Ensor	1	1	1	1	0	0	0		17.1	11.2		11.8	15.3		21	24.3	
34	35	side	12	Ensor	1	1	1	0	0	1	1	0.5	26.1	11.8		13.9	16.6	35.4	21.4	28.5	6.7

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
35	36	side	12	Ensor	1	1	1	0	0	1	1	0.9	8.3	6.7	38.1	9.3	12	25.1	17.6	21.8	9.4
36	36	side	12	Ensor	0	1	1	0	0	1	1	0.9	10.6	7.3	43.3	11.6	11.6	30.5	17	20.3	10.9
37	37	side	12	Ensor	1	1	1	0	0	0	0		21.8	10.1		8.6	11.9	37.6	18.6	21.2	12.4
38	38	side	12	Ensor	0	1	1	0	0	0	1		20.5	9.3	55.6	8.1	11.1	37.1	19.3	22.2	16.2
39	39	side	12	Ensor	0	1	1	0	0	1	1	0.4	12.4	7.9	50.3	9.7	13.4	29.2	15.9	21.8	10.2
40	40	side	12	Ensor	1	1	1	0	0	1	0		7.8	7.7		12.1	12.1	30.1	16.5	19.7	10.1
41	41	side	12	Ensor	1	1	0	1	0	1	0		7.2	6.8		13.4	13.4	34.1	20	22.5	10.7
42	42	side	12	Ensor	1	1	1	0	0	0	0		11.3	8.7		9.8	15.5		15.7	17.7	6.8
43	43	side	12	Ensor	0	1	1	0	0	0	1		12.7	8.3	47.5	13.4	13.4	30	19.8	23	10.5
44	44	side	12	Ensor	1	1	1	0	0	1	0		10.8	7.6		6.3	8.1	22.7	13	14	11.1
45	45	side	12	Ensor	1	1	1	0	0	0	1		34.9	9.2		15.3	15.3	38.2	19	23.7	12.4
46	46	side	12	Ensor	1	1	1	0	0	1	1	0.4	19.4	8.3		12	12	39.2	22.8	22.5	10.1
47	47	side	12	Ensor	0	1	1	0	0	0	0		13.5	10.4		18.6	18.6				
48	48	side	12	Ensor	1	1	1	1	0	1	1	0.5	10.9	8.9	41.8	6.2	8	30.2	18.1	21.1	
49	49	side	12	Ensor	1	1	1	0	0	0	0		14.6	9.1		11	11	33.3	18.7		12.6
50	50	side	12	Ensor	1	1	1	1	0	1	0		7.1	7.4		6.9	11.5		17.6	20.7	9.4
51	51	side	12	Ensor	1	1	1	0	0	1	0		23.6	8.6		6.9	12.6	37.6	23.8	27	12.4

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
52	52	side	12	Ensor	0	1	1	1	0	1	1	1	14	9.1		10.6	13.4	30.9	18	21.6	14.9
53	53	side	12	Ensor	1	1	1	1	0	1	0		14.4	9.6		8.2	14.8	31.2	20.9	26.4	12.8
54	54	side	12	Ensor	1	1	1	0	0	1	0		6.5	7.5		8.3	12.2	23.7	13.1	17.4	8.3
55	55	side	12	Ensor	1	1	1	0	0	0	0		12.7	7.8		13	13	33.8	20.6	23.8	13.5
56	56	side	12	Ensor	1	1	1	0	0	1	0		6.3	7.1		7.2	10.5	27.2	17.1	21.5	9.6
57	57	side	12	Ensor	1	1	0	0	0	0	0		8.8	8.2		11.2	12	30.9	17.6		11
58	58	side	12	Ensor	1	1	1	0	0	1	0		15.3	10.1	37.4	13.5	18.1		20.4	26	14.8
59	59	side	12	Ensor	1	1	1	0	0	1	0		11	9.3				39.2	22.2		
60	60	side	12	Ensor	1	1	1	0	0	0	0		8	8.8		10.8	13.9	29.7	17.7	19.5	11.8
61	61	side	12	Ensor	1	1	1	1	0	0	1		8.6	7.3	39.1	7.6	9.2		15.7	19.5	7.5
62	62	side	12	Ensor	1	1	1	0	0	0	0		9.4	8.3		10.5	15.8		22.4		15.9
63	64	side	12	Ensor	1	1	1	0	0	0	0		7.8	6.9		13	15.4		20.4	25.2	9.1
64	65	side	12	Ensor	1	1	1	0	0	0	0		8.9	9.4		9.7	9.7		15.8	17.7	9.4
65	66	side	12	Ensor	1	1	1	0	0	0	0		6.3	6.2		7.1	10.5		18.3	23.2	9.6
66	67	side	12	Ensor	1	1	1	0	0	0	0		16.3	9.9			13.1				13.5
67	68	Corner	11	Ellis	0	1	1	0	0	1	1	0.5	5.8	5.9		9.3	9.7		18.2	20.9	
68	69	Corner	11	Ellis	0	1	1	0	0	0	1		15.9	8.4	45.6	16	15	36.8	23	29.6	13.7

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
69	70	Corner	11	Ellis	1	1	1	0	0	1	1	0.6	11.6	6.8	34.9	12	15.3		21.5		
70	71	Corner	11	Ellis	1	1	0	0	1	1	0		10.9	7.3		15	15		21.2	26.8	12.4
71	72	Corner	11	Ellis	1	1	1	0	0	1	1	0.3	14.5	7.4	42.8	13.3	13.3		22.2	25.4	17.5
72	73	Corner	11	Ellis	1	1	1	0	0	1	1	0.8	12.7	7.2	40.3	12.1	12.1	33.1	21	24.5	11.3
73	74	Corner	11	Ellis	0	1	1	0	0	1	1	0.3	12.5	9.4	37.2	9.3	15	33	22.9	27.3	14.2
74	75	Corner	11	Ellis	0	1	1	0	0	0	0		12.5	8.1					18.6		13.8
75	76	Corner	11	Ellis	1	1	1	0	0	0	0		7.9	6.7		12.9	12.9	29.3	13.9	18	11.7
76	77	Corner	11	Ellis	1	1	0	0	0	1	1	1	13	8	25.7	11	12.5	34.4	21.4		12.3
77	78	Corner	11	Ellis	0	1	1	0	0	0	1		15.1	8.5		14.1	14.1		22.5	24.5	
78	79	Corner	11	Ellis	0	1	1	0	0	0	1		10.6	8	31.6	15.5	15.5	30	22.1	26.8	11.7
79	80	Corner	11	Ellis	1	1	1	0	0	1	1	0.9	14.7	9.4	33.6	13.9	13.9		22.1	24	11.4
80	81	Corner	11	Ellis	0	1	1	0	0	0	1		11.5	8.4	41.2						8.5
81	82	Corner	11	Ellis	1	1	1	0	0	0	1		4	6	26.9	7.2	7.2	26.5	12.4		
82	83	Corner	11	Ellis	0	1	1	1	1	0	1		9	5.4	43.4	12.6	12.6	31.6	17.5	21.8	8.5
83	84	Corner	11	Ellis	0	1	1	0	0	0	0		8	7.8		12.2	12.2		20.6	21.9	
84	85	Corner	11	Ellis	0	1	1	0	0	1	1	1	13.1	8.7	21	12.8	14.3	38.6	22.4	25.3	9
85	86	Corner	11	Ellis	0	1	1	0	0	0	1		27.1	10	62.2	19	19	40.7	22.6		19.3

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to-Corner mm
86	87	Corner	11	Ellis	0	1	1	0	0	0	1		14.3	9.2	48.5	11.4	11.4		17.2	16.6	
87	88	Corner	11	Ellis	1	1	1	0	0	1	1	1	10.2	7	27.7	9.6	12.8	31.8	21	23.6	11.7
88	89	Corner	11	Ellis	0	1	1	0	0	1	1	0.9	17.7	8.9	29.8	12.6	13.3		23.4	23.3	
89	90	Corner	11	Ellis	0	1	1	0	0	1	1	0.6	8.5	6.2	37.5	12	13.4	29.4	15.9	21.9	9.4
90	91	Corner	11	Ellis	0	1	1	0	0	0	1		15.9	9.9	46.9	17.3	17.3	38	19.8	20.2	16.5
91	92	Corner	11	Ellis	0	1	1	0	0	1	1	0.3	22.5	8.9	46.3	17.1	17.1		25.1	31.3	
92	93	Corner	11	Ellis	0	1	1	0	0	0	1		10.4	6.3	4.5	11.3	11.3	30.2	21.5	23.2	9.2
93	94	Corner	11	Ellis	0	1	1	0	0	0	0		7.6	5.8		8.2	8.2		17.5	18.1	
94	95	Corner	11	Ellis	1	1	1	0	0	0	0		7.6	6.2		11.2	11.2		19.3		10.3
95	96	Corner	11	Ellis	0	1	1	0	0	0	1		6.6	6.5	34.5				14		
96	97	Corner	11	Ellis	1	1	1	0	0	1	1	0.4	9.8	7.5	29.5	10.8	11.7		16.8	20.5	
97	98	Corner	11	Ellis	0	1	1	0	0	1	1	0.6	9.1	7.2	29.6	10.4	13.8	27.7	20.4	21.4	12.5
98	99	Corner	11	Ellis	0	1	1	0	0	1	1	0.9	8.5	7.9	40.2	9.6	9.6	28.8	16.5	19.6	8.2
99	100	Corner	11	Ellis	0	1	1	0	0	0	0		6.1	7.5		11.8	11.8		20.6		11.3
100	101	Corner	4	Uvalde	1	1	1	0	0	0	0		13.1	7.4		12.2	12.2	39.8	20	21.1	11
101	102	Corner	4	Uvalde	1	1	1	0	0	0	0		13.2	10.2		12.6	12.6	40.1	17.7		5.2
102	103	Corner	5	Lange	1	1	1	0	0	1	0		16.9	9		15.3	15.3	31.3	19.2	15.8	16.6
103	105	Basal	2	Smith	0	1	1	0	0	0	0		27.6	8.4		13	13	63.4	23	23.6	5.3

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
104	106	Basal	2	Smith	0	1	1	0	0	1	1	0.9	38.5	13.8	74.9	7.5	7.5	40.9	10.5	11.2	8.2
105	107	stem	17	Langtry	0	1	1	0	0	1	1	0.7	6.1	5.7	33.9	15.4	15.4	29.1	29.1	13	12.5
106	108	Corner	3	Frio	1	1	1	0	0	0	0		11.5	8.5		16.1	16.1				8.8
107	111	Corner	6	Williams	1	1	1	0	0	0	1		22.2	9.5		14	14	43	27.5	33.8	7.1
108	112	Corner	6	Williams	1	1	1	0	0	0	0		11.4	9.4		10	15.1		25.4	29.3	
109	113	Corner	18	Cupp	1	1	0	0	0	0	0		8	7.1		14	14	29.2	15.9	19	7.8
110	114	Corner	18	Cupp	0	1	0	0	0	0	0		12.3	6.7		14.3	14.3	33.2	10.5	17.3	10.6
111	115	Corner	4	Uvalde	1	1	0	0	0	0	1		20.9	9.6		12.5	12.5	43	18.3	22.6	4.8
112	116	Corner	10	St. Charles	0	1	1	0	0	0	0		8.5	7.8		10.3	10.3		17.3		6.5
113	117	Corner	6	Williams	0	1	1	0	0	0	1		10.9	6.7	50.3	12.5	13.1		18.8	20	8.7
114	118	Corner	11	Ellis	1	1	1	0	0	0	1		9.1	8.3		9.2	10	25.1	16.2		
115	119	Corner	7	Marcos	0	1	0	0	0	1	1	0.9	7.3	8.2	19	12	12	33	22.1	24.1	13.1
116	120	Corner	11	Ellis	0	1	1	0	0	0	1		3.3	5.4	27.5	6.2	7.6	18.9	14.4	13	7.5
117	121	Basal	9	Marshall	0	1	1	1	0	1	0		4.6	4.4	26.5	7.5	7.5	24.1	13.7	8.8	8.9
118	122	Basal	9	Marshall	1	1	1	0	0	1	0		7.7	6.8		8.1	8.1		14.3	14.1	
119	123	Basal	9	Marshall	1	1	1	0	0	1	0		6.8	7.4	29.4				15.8		
120	124	side	12	Ensor	0	1	1	0	0	1	1	1	6.3	7.9	18.2	10.8	14.6	25.9	24.6	27.4	

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to-Corner mm
121	125	stem	14	Yarbrou-gh	0	1	1	0	1	0	1		6.2	6.6	36.9	9.5	9.5	24.3	16.5	16.5	12.8
122	126	stem	17	Langtry	0	1	1	0	0	1	1	1	10.5	9.3	43.5	7.4	7.4	28.7	28.7	15.9	7.3
123	127	stem	17	Langtry	0	1	1	0	0	1	1	0.9	9.2	9.4	24.3	19.4	19.4	23.9	23.9	15.4	14.7
124	128	stem	17	Langtry	1	1	1	0	0	0	0		13.9	8.5		17.8	17.8	33.2	33.2	17	16.9
125	129	stem	17	Langtry	0	1	1	0	0	0	1		9.6	6.3	39.9	19.4	19.4	30.8	30.8	14.8	15.8
126	130	stem	17	Langtry	1	1	1	0	0	1	0		22.6	8.7		20	20	36.5	36.5	15.6	17.1
127	131	stem	17	Langtry	0	1	1	1	0	1	1	1	19.2	9.6	38.9	15.9	15.9	36.9	36.9	18.5	13.8
128	132	stem	17	Langtry	1	1	1	0	0	0	0		10	7.7		18.7	18.7	27.3	27.3	17.9	16.4
129	133	stem	17	Langtry	0	1	1	0	0	1	1	0.6	17	5.6	73	19.8	19.8	32.6	32.6	11.6	19.4
130	134	stem	17	Langtry	1	1	1	0	0	1	0		5.2	5.1		16.9	16.9	32	32	15.5	14.4
131	135	stem	17	Langtry	1	1	1	0	0	1	0		38.7	9		24.1	24.1	54.3	54.3	30.6	22.1
132	136	stem	17	Langtry	0	1	1	0	0	1	1	0.8	7.1	7.6	31.1	15.4	15.4	25.3	25.3	12	14
133	137	stem	17	Langtry	0	1	1	0	0	1	1	0.8	8.7	7.8	35.1	17.1	17.1	27.8	27.8	13.8	16.1
134	138	stem	17	Langtry	1	1	1	0	0	1	0		27.1	11.7		16.4	16.4	35	35	18.1	14.2
135	139	stem	17	Langtry	1	1	1	0	0	1	0		6.2	5.9		11.8	11.8	24	24	13	12.2

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
136	140	stem	17	Langtry	1	1	1	1	0	0	0		9.9	6.8		17.4	17.4	32.2	32.2	15	14.6
137	141	stem	17	Langtry	0	1	1	0	0	0	1		12.7	10.1	37.2	19.4	19.4	33.8	33.8	13.1	17.2
138	142	stem	17	Langtry	0	1	1	0	0	1	1	0.9	15.3	8	44	12.2	12.2	34	34	20.9	7.6
139	143	stem	17	Langtry	1	1	1	0	0	1	0		14.9	9.4		14.1	14.1	33.7	33.7	17.6	13.6
140	144	stem	17	Langtry	0	1	1	0	0	1	1	0.9	14.4	9.1	39.4	18.7	18.7	33.6	33.6	16.1	15
141	145	stem	17	Langtry	1	1	1	1	0	1	0		9.2	6.7		12.3	12.3	31.2	31.2	16.3	9.9
142	146	stem	17	Langtry	0	1	1	0	0	1	0		11.4	8.2		22.1	22.1	32.5	32.5	12.2	22.6
143	147	stem	17	Langtry	1	1	1	0	0	0	1		11.9	9.6	38	15.6	15.6	26.9	26.9	11.2	13.3
144	148	stem	17	Langtry	0	1	1	0	0	0	1		6.5	8.5	29.9	18.2	18.2	26	26	9.1	15.9
145	149	stem	17	Langtry	1	1	1	0	0	1	0		31.4	10.8		24.5	24.5	45.3	45.3	22.2	20.9
146	150	stem	17	Langtry	0	1	1	0	0	1	1	0.7	21	8.7	47.2	14.4	14.4	35.2	35.2	22.6	12.2
147	151	Corner	11	Ellis	0	1	1	0	0	1	1	0.9	13.2	9.2	31.3	16.6	18.5	34.1	23.6	20.3	18.3
148	152	Corner	11	Ellis	0	1	1	0	0	1	1	0.9	9.9	8.9	34.2	12.6	12.6		16.6		9.6
149	153	Corner	11	Ellis	0	1	1	0	1	0	1		7.3	8.1	34.7	8.7	12		19.5	16.3	12.4
150	154	Corner	11	Ellis	1	1	1	0	1	1	1	0.7	9.5	6.1	34.2	14	15.8	32	23.5		11.9
151	155	Corner	1	Stanley	0	1	1	0	0	0	1		18.5	10	53.6	6.7	8.2	44.5	19.1		8.8
152	156	Corner	11	Ellis	0	1	0	1	0	0	1		5.8	5.2	31.3	12.2	12.2		22.2	25.7	7.6
153	157	Corner	11	Ellis	1	1	1	0	0	1	1	0.8	11.6	8.1	37.9	11.6	11.6	34.8	24.4	25.1	9

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
154	158	Corner	11	Ellis	1	1	1	0	1	0	0		13.6	8.5		14.1	14.1		22.8	26.1	10.1
155	159	Corner	11	Ellis	1	1	1	0	0	1	1	0.9	16.5	9.5	36.1	33.5	15.8		21.8	24	
156	160	Corner	11	Ellis	1	1	1	0	0	0	0		7.4	7.6		12.3	12.3		16.4	19.8	
157	161	Corner	11	Ellis	1	4	0	0	1	1	0		6.9	6		12.9	12.9		19.7	22.4	7.8
158	162	Corner	11	Ellis	1	1	1	0	0	1	1	1	6.8	5.2	30.4	9.8	9.8			21	
159	163	Corner	11	Ellis	0	1	1	0	0	0	1		6.1	6.2	29.8	11.9	11.9	24.2	15.8		8.9
160	164	Corner	11	Ellis	1	1	1	0	0	1	1	0.4	11.5	7.7	34.3	9	11.7	32.4	17.1	22.4	9.9
161	165	Corner	11	Ellis	1	1	1	0	0	0	0		8.1	7.9		8	12.5		15.9		10.7
162	166	Corner	11	Ellis	1	1	1	0	0	0	0		11.2	7.8		13	13		20.9	22.6	
163	167	Corner	11	Ellis	1	1	1	0	0	0	0		9.8	7.6		13.8	15.2		18.5		13
164	168	Corner	11	Ellis	0	1	1	0	0	0	0		10.7	7.1		12.6	12.6	34.3	20.9	24.5	11.5
165	169	Corner	11	Ellis	0	1	1	0	0	0	0		9	7.4		15	15.4		16.8		8.8
166	170	Corner	11	Ellis	1	1	1	0	0	0	0		8.8	7.7		10.7	14		19.1	21.7	
167	171	Corner	11	Ellis	1	1	1	0	0	0	1		10.6	8.4		11	13.3	31	25	26.6	10
168	172	Corner	11	Ellis	0	1	1	0	0	0	0		6.5	8.8		7.3	11.8		21.4	23.3	12
169	173	Corner	11	Ellis	1	1	1	0	0	1	1	0.9	4.4	6.9	21	12.6	12.6		16.5	19.6	9.8
170	174	Corner	11	Ellis	1	1	1	0	0	1	1	0.8	11.5	8.4	34.7	12.7	12.7	31.5	19.6	24.9	12.2
171	175	Corner	11	Ellis	1	2	0	1	0	1	1	0.6	14.5	10	26.2	11.6	15.1	35.4	20.9	25.4	14

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
172	176	Corner	6	Williams	1	1	1	1	0	0	1		24.4	7.9		12	14.6		20.1		8.5
173	177	Corner	6	Williams	0	1	1	0	0	0	1		22.8	9.8	51.6	10.4	14.8	38.4	21.2		13.9
174	178	Corner	6	Williams	1	1	1	1	0	0	0		22.2	8.7		17.8	17.8	41.9	23.6	28.5	11.3
175	179	Corner	6	Williams	0	1	1	0	0	0	1		14.6	6.6	58.9	10.5	12.6	36.1	15.7	20.1	10.9
176	180	Corner	6	Williams	1	1	1	0	0	0	0		11.9	7.8		10.7	12.4	36	19.5	20.9	7
177	181	Corner	6	Williams	0	1	1	0	0	0	1	1	10.7	7.8	23	10	12.7		19.1	24.3	
178	182	Corner	6	Williams	1	1	1	0	0	0	0		9.7	7.5		11.4	14.5		18.9	25.2	
179	183	Corner	6	Williams	1	1	1	0	0	0	0		15.6	7.9		10.5	14.7	41	21.3	27.8	7.2
180	184	Corner	6	Williams	1	1	1	0	0	0	0		9.8	7.2		12.6	12.6		19.4	21.1	13
181	185	Corner	6	Williams	1	1	1	0	0	0	1	0.9	13	8.2	49.6	9.9	11.2	33	19.2	23.8	7.6
182	186	Corner	6	Williams	0	3	0	0	0	1	1	0.5	16	9.9	46.8	7.8	10.8	35	22.6	26.1	8.5
183	187	Corner	6	Williams	1	1	1	0	0	0	1		17.7	9.1		13	14.7		22.4		7.7
184	188	Corner	6	Williams	0	1	1	0	1	0	0		11	7.6		12.4	18.4	37.9	25.9	31.1	10.6
185	189	Corner	6	Williams	1	1	1	1	0	0	0		13.8	6.6		8.3	10.8	37	20.7	24.1	6.3
186	190	Corner	6	Williams	1	1	1	0	0	0	1		17	8.6		16.6	16.6		23.6	28.8	15
187	191	Corner	6	Williams	1	1	1	0	0	0	0		14.5	8.4		14.9	14.9	46.3	26.5	31.8	12.5
188	192	Corner	6	Williams	1	1	1	0	0	0	0		15	8.4		14.8	14.8		22.8	25.5	14.5
189	193	Corner	6	Williams	1	1	1	0	0	0	0		8.5	7.3		10.5	10.5		17.1	20.1	5.1

Appendix A: Tabulated Metric and Observational Data																					
#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
190	194	Corner	6	Williams	1	1	1	0	0	0	0		13.2	9.1		12.2	12.2		19.3	24.2	
191	195	Corner	6	Williams	1	1	1	0	0	1	1	0.6	28.6	10.1		12.8	18		28	34.3	13.8
192	196	Corner	6	Williams	1	1	1	0	0	1	1	0.3	14.5	8.3	38.3	11.5	13.2		23.9	27.7	7.8
193	197	Corner	6	Williams	1	1	1	0	0	0	0		8.3	8.5		10.6	14.2		21	22.8	
194	198	Corner	6	Williams	1	1	1	0	0	1	1	0.9	8.7	7.6	21.8	12.2	23.1	38.7	16.5	23	10.5
195	199	Corner	6	Williams	0	1	1	0	0	0	0		9.8	8.3		9.9	11.2		16.6		9.7
196	200	Corner	6	Williams	0	1	1	0	0	0	1		11.2	5.5	56.3	12.1	12.1	33.8	20.2	24.4	10.2
197	201	Corner	6	Williams	1	1	1	0	0	0	0		9.5	8.9		11.7	14		21.1	27.1	
198	202	Corner	6	Williams	1	1	1	0	0	0	0		9	6.8		14	14		22.8		
199	203	Corner	6	Williams	1	1	1	0	0	1	0		8.9	7.4		11.2	11.2	39.1	19.5	23.2	9.8
200	204	Corner	6	Williams	1	1	1	0	0	0	0		7	6					17.5		
201	205	Corner	6	Williams	1	1	1	0	0	1	1		15.3	7.6		12.4	13.4	31.2	18.3	26.8	6.7
202	206	Corner	6	Williams	1	1	1	0	0	1	1	0.9	11.5	6.6		8.4	10.9	32.4	16.1	21.1	9.8
203	207	Corner	6	Williams	1	1	1	0	0	0	0		10.8	7.7		7.5	11.2		19.4		8.9
204	208	Corner	6	Williams	0	1	1	0	1	0	1		18.2	9.5	46	9.8	12.9	33.4	21	26.4	6.1
205	209	Corner	6	Williams	1	1	1	0	0	0	0		8.7	7.4		10.5	13.1	31.6	17.2	19.2	11.5
206	210	Corner	6	Williams	0	1	1	0	0	0	1		10.1	3.4	43.8	2.2	2.2	24.6	9.9	12	7.3
207	211	Corner	6	Williams	1	1	1	0	0	1	1	0.4	19.4	7.6		13.2	15.1	40.1	19.9	24.1	8.5

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
208	212	Corner	6	Williams	1	1	1	0	0	1	1	0.5	11.4	7.4	33.9	11.8	11.8		18.8	25.8	
209	213	Corner	6	Williams	0	1	1	0	0	0	0		11.4	9.4		12	12	32.4	21.6	27.8	6
210	214	Corner	6	Williams	0	1	1	0	0	0	0		12.1	9.4		11.9	16		25.4	32.4	7.7
211	215	Corner	6	Williams	1	1	1	0	0	1	0		9.2	7.6		6.6	9.4	34	17.4	20.4	8.2
212	216	Corner	6	Williams	0	1	1	0	0	0	1		9.4	8.6	40.6	10.5	10.5		17		5.8
213	217	Corner	6	Williams	0	1	1	0	0	0	0		6.5	7.6		13.4	13.4		21.6	25.4	7.3
214	218	Corner	6	Williams	1	1	1	0	0	0	0		10.5	6.4		11.7	11.7		19.9	23.1	3.8
215	219	Corner	6	Williams	1	1	1	0	0	0	1		14.4	8.7		10	12.8		25	28.7	5.5
216	220	Corner	6	Williams	0	1	1	0	0	0	0		19.5	9.4		13.2	17.5	43.8	22.2	26.9	8.7
217	221	Corner	6	Williams	1	1	1	0	0	0	0		13.6	7.8		8.5	11.3	37.9	18.9	20.1	9.3
218	222	Corner	6	Williams	0	1	1	0	0	0	0		8.9	7.1					21.2		
219	223	Corner	6	Williams	1	1	1	0	0	0	0		10.3	7.1		7	10.5		17.3	20.9	
220	224	Corner	8	Afton	0	1	1	0	0	0	0		39.8	13.6		16.8	16.8	43.8	21.6	21.5	15.3
221	225	Corner	8	Afton	0	1	1	0	0	1	1	0.8	15.8	12.1	43.1	14.6	14.6	36.2	14.1	19.6	9.2
222	226	Corner	8	Afton	1	1	1	0	0	0	0		7.1	6.5		8.8	8.8		15.2	20.5	5.4
223	227	Corner	8	Afton	0	1	1	0	0	0	0		13.4	9.3		15	15			24	13.9
224	228	Corner	8	Afton	0	1	1	0	0	0	0		18.3	11.7		10.2	10.2				11.7
225	229	Corner	8	Afton	1	1	1	1	0	0	0		10.9	6.2		11.5	11.3		18.7	20.5	8.5

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to-Corner mm
226	230	Corner	8	Afton	0	1	1	0	0	1	1	0.5	15.4	8	58.1	9.3	9.3	34.9	16.5	18.4	8
227	231	Corner	8	Afton	0	1	1	0	0	0	0		16.5	10.1		17.8	17.8	41.7	23.8	21	15.9
228	232	Corner	8	Afton	0	1	1	0	0	1	0		9.2	6.4	50.6			27.8	13.5		
229	233	Corner	8	Afton	0	1	1	0	0	1	1	0.5	16.6	7.5	55.8	10.7	10.7	40.8	18.4	21.7	10.2
230	234	Corner	8	Afton	1	5	0	0	0	1	0		21.5	7.4	75.4			37.4	18.9		
231	235	Corner	8	Afton	1	1	1	0	0	1	0		16.8	8.8		10.6	10.6				6.9
232	236	Corner	8	Afton	0	1	1	0	0	1	1	0.4	23.7	5.2	6.2	13.1	13.1	30.9	19.2	22.9	8.9
233	237	side	15	Edgewo-od	1	1	1	0	0	1	0		9.8	7.9		14	14	28	20.4	23.6	14.7
234	238	side	15	Edgewo-od	1	1	1	0	0	1	0		11.2	7.7	27	12.3	12.3	34.6	24.1	31.5	11.2
235	239	side	15	Edgewo-od	1	1	1	0	0	1	0		14.8	7.8	39.2	15.3	15.3	35	24.1	24.7	18.1
236	240	side	15	Edgewo-od	1	1	1	0	0	1	1	0.5	13.7	6.3	49.1	8.9	8.9	35.2	15.2	18	9
237	241	side	15	Edgewo-od	1	1	1	0	0	1	0		5.3	6.5	32.9	11	11		20	24.8	9.8
238	242	side	15	Edgewo-	0	1	1	0	0	1	1	0.5	18.2	6.8	48	8.9	8.9	34.2	16.1	20.6	13.2

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
				od																	
239	243	side	15	Edgewo-od	0	1	0	0	0	1	1	0.6	4.8	3.5	25.9	9	9	19.6	11.4	13	11.4
240	244	side	15	Edgewo-od	1	1	1	0	0	1	0		17.5	8.7	51.2	14	14		25.2		15
241	245	side	15	Edgewo-od	1	1	1	0	0	1	0		10.4	8.9		12.9	12.9		16	16.6	12.4
242	246	side	15	Edgewo-od	1	1	1	1	0	0	0		9.5	6.9		19.3	19.3		21.5	27.3	
243	247	side	15	Edgewo-od	1	1	1	0	0	0	0		3.9	6.1		9	9		15.3	17.5	
244	248	side	15	Edgewo-od	1	1	1	0	0	1	0		6.2	6		9	9		15.1	20.8	6.9
245	249	side	15	Edgewo-od	0	1	1	0	0	0	0		8.8	8.9		12.7	12.7	31.8	20.4	23.8	12.1
246	250	Corner	7	Marcos	1	1	1	0	0	0	0		17.2	7.7		16.3	16.3		22.1	28.9	9.7
247	251	Corner	7	Marcos	1	1	1	0	0	1	1	1	21.1	8.1	54	13.6	13.6	42.8	23.5	23.1	12.7
248	252	Corner	7	Marcos	1	1	1	1	0	0	0		14.4	8.4		9.2	9.2		20.3	23	10.1

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
249	253	Corner	7	Marcos	1	1	1	0	0	1	1	0.8	10.8	6.4	42	11.6	11.6		21.8	26.5	
250	254	Corner	7	Marcos	0	1	1	0	0	0	1		6.3	6.7	41.4	11	11		17.7	18.1	8
251	255	Corner	7	Marcos	1	1	1	0	0	1	1	0.9	14.6	7.9	50.3	13.9	13.9		21	23.5	7
252	256	Corner	7	Marcos	0	1	1	0	0	0	0		8.5	6.5		10.5	10.5		16.7		
253	257	Corner	7	Marcos	1	1	1	1	0	0	0		10.2	7.7		14.4	14.4		21.6	27.9	
254	258	Corner	7	Marcos	1	1	1	0	0	1	1	1	10.2	7.5	38.8	13.2	13.2		22.1	27.5	11.3
255	259	Corner	7	Marcos	1	1	1	0	1	0	0		4.9	6		10.5	10.5		17.1	19.9	8.3
256	260	Corner	7	Marcos	1	1	1	0	0	1	1	0.8	19.3	8.8	57.8	12.4	12.4	45.7	22.5		8.6
257	261	Corner	7	Marcos	0	1	0	1	0	1	0		11.6	7.8		15.5	15.5		19.7	23.4	6.1
258	262	Corner	7	Marcos	1	1	0	1	0	0	1		9.8	5.5		8.6	8.6	33.9	15.6	20.3	4.7
259	263	Corner	7	Marcos	0	1	1	0	0	1	1	0.8	7.6	5.6	42.3	11.1	11.1	32.3	17.5	19.8	10
260	264	Corner	7	Marcos	0	1	1	0	0	1	1	0.9	20.1	7.3	76.2	17.4	17.4	33.1	18.7	26.6	8.5
261	265	Corner	7	Marcos	0	1	1	0	0	1	1	0.8	31.3	10.1	95	10	10		19.6	17.4	9.3
262	266	Corner	7	Marcos	0	1	1	0	0	1	0		6.7	6.2		10.7	10.7	29.7	16.2	20.6	7.6
263	267	Corner	7	Marcos	1	1	0	1	0	1	1	0.3	10.3	9.1	46.8	8.9	8.9	26.7	14.5	19.3	5.6
264	268	Corner	7	Marcos	0	1	0	0	0	1	1	0.9	18.7	8.5	62.7	15	15		19.4	22.2	12
265	269	Corner	7	Marcos	0	1	1	0	0	0	1		16.1	8.5	57.5			41.2	19.5		
266	270	Corner	7	Marcos	0	1	1	0	0	1	1	0.4	14.3	8.7	59.4	13	13	28.5	16	19.7	9.6

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
267	271	Corner	7	Marcos	0	1	1	0	0	0	1		31.3	11.2	67.3	14.7	14.7	43.9	28.3	13.8	10
268	272	Corner	7	Marcos	0	1	1	0	0	1	1	0.9	15.2	8.5	74.4	11	11	31.1	14.9	19.3	8.3
269	273	Corner	7	Marcos	0	1	1	0	0	0	1		24.2	9.5	73.3	11.4	11.4		19.5	18.7	15
270	274	Corner	7	Marcos	0	1	1	0	0	1	1	0.5	8.9	6.8	5	9.6	9.6		15.6	22.1	7.9
271	275	Corner	7	Marcos	1	1	1	0	0	0	0		18.5	7.7		18.1	18.1		24.7	29.9	
272	276	Corner	7	Marcos	0	1	1	0	0	1	1	0.4	11.6	8.6	49.2	7.6	7.6		18.9	20.3	7.3
273	277	Corner	7	Marcos	1	1	0	0	0	0	0		13.2	7.7		16.7	16.7		22.4		
274	278	Corner	7	Marcos	0	1	1	0	0	0	0		14	10.1		11	11	38.5	18.7	18.3	12.9
275	279	Corner	7	Marcos	1	1	1	0	0	1	0		14	7.4		11.6	11.6	43.6	24.5	26.6	7.7
276	280	Corner	7	Marcos	0	1	1	0	0	0	1		8.1	6.5	44.9	11.2	11.2		17.1	20.3	8.7
277	281	Corner	7	Marcos	1	1	1	0	0	0	1		11.9	7.5	41.6	12.3	12.3	36.6	17.3	21.9	7.1
278	282	Corner	7	Marcos	0	1	1	0	0	1	1	0.9	11.3	6.9	44.5	11.5	11.5	27.9	17.2	22.8	9.7
279	283	Corner	7	Marcos	0	1	1	0	0	1	1	0.9	12.1	8.2	43	13.7	13.7		19.4	23.4	12
280	284	Corner	7	Marcos	1	1	1	0	0	0	0		6.2	5.6		9.5	9.5			18.6	6.7
281	285	Corner	7	Marcos	1	1	1	0	0	0	0		8.6	7		10.9	10.9		19.4	23.4	8.4
282	286	Corner	7	Marcos	1	1	1	0	0	1	1	1	5.8	5.8		10.7	10.7		13.1	20.3	5.3
283	287	Corner	7	Marcos	1	1	1	0	0	1	1	0.8	12.2	6.7		12	12	33.7	17.9	19.9	7
284	288	Corner	7	Marcos	1	1	1	0	0	0	1	0.4	17.2	8.2		15.4	15.4		17	23.5	9.9

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
285	289	Corner	13	Snyders/ Cooper	1	1	1	0	0	0	0		22.1	10		10.1	11.8	45.3	19.1		3.8
286	290	Corner	13	Snyders/ Cooper	1	1	1	0	0	0	0		18.5	7.1		9.8	11.3		14.6	19.1	4.2
287	291	Corner	13	Snyders/ Cooper	1	1	1	0	0	0	0		34.5	12.5		16	20.6		37	37.6	9.5
288	292	Corner	13	Snyders/ Cooper	0	1	1	0	0	1	1	0.6	41.1	9.5	56.6	13.6	13.6	52.8	22.4	24	9.1
289	293	Corner	13	Snyders/ Cooper	0	1	1	1	1	0	1	0.4	60.5	14.1	64.2	13.1	13.1	52.6	20.9	22	8.2
290	294	Corner	13	Snyders/ Cooper	1	1	1	0	0	1	1	0.4	25.2	9.5	40.6	15	15	45.6	29.1	29	7.9
291	295	Corner	13	Snyders/ Cooper	0	1	1	0	0	1	1	0.3	19	8.6	38.5	12.4	12.4	44.3	23	27.8	6.7
292	296	Corner	13	Snyders/ Cooper	0	1	1	0	0	0	1		6.3	2.9	36.4	8.8	8.8	35.7	15	14.9	6.8
293	297	Corner	13	Snyders/ Cooper	0	1	1	0	0	0	1		13.3	6	45.2	11.3	11.3	40	19.5	23	4.8

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
294	298	Basal	9	Marshall	1	1	1	0	0	0	0		11.8	7.7		14.1	14.1		22.1	26.1	13.1
295	299	Basal	9	Marshall	0	1	1	0	0	1	0		17.9	7.1		12.8	12.8	37.9	20.1	26	9.2
296	300	Basal	9	Marshall	1	1	1	1	0	0	0		16.7	7.5		12.6	12.7	46.9	24.1	27.8	12.1
297	301	Basal	9	Marshall	0	1	1	0	0	1	1	0.7	12.2	6.5	41.1	12.8	12.8	41.3	21.4	25.5	4
298	302	Basal	9	Marshall	1	1	1	0	0	1	0		19.3	8.3		14.1	14.1		19.3	21.6	12.2
299	303	Basal	9	Marshall	1	1	1	0	0	1	0		12.2	7.3		11.8	11.8		19.6	24.1	9.9
300	304	Basal	9	Marshall	1	1	1	0	0	1	0		20.6	8.2	52.3	12.8	12.8		21.7	19.8	15.3
301	305	Basal	9	Marshall	1	1	1	0	0	1	0		15.9	7.7		16.3	16.3		21.3	23.2	12
302	306	Basal	9	Marshall	0	1	1	0	0	0	1	0.5	17.2	3.9	57	10	10	42.1	15.1	18.9	4.5
303	307	Basal	9	Marshall	1	1	1	0	0	1	1	0.7	9	6.1	41	10.7	10.7	31.8	15.3	15.8	7.3
304	308	Basal	9	Marshall	1	1	1	0	0	1	1	0.9	22.6	7.4		10.6	10.6	42.1	20.4	20.4	
305	309	Basal	9	Marshall	0	1	1	0	0	0	0		14	8.5	51	10.4	10.4	38.1	16.9	17.8	5.8
306	310	Basal	9	Marshall	1	1	1	1	0	1	0		12	7.8		13.8	19.4		23.8	23.8	7.8
307	311	Basal	9	Marshall	0	1	1	1	0	1	1	0.4	16.9	7.7	43.8	8	8	31.5	12	13.5	3.1
308	312	Basal	9	Marshall	1	1	0	0	0	0	0		8.5	6.5		9.1	9.1		16	17.1	
309	313	Basal	9	Marshall	1	1	1	0	0	0	0		12.2	8.5		12	12		18.2	21.7	
310	314	Basal	9	Marshall	0	1	0	1	0	1	0		8.2	6.5		9.4	9.4	44.8	18.9		4.5
311	315	Basal	9	Marshall	0	1	1	0	0	0	0		10.9	7.9		13.8	13.8		22.1	21.8	14

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
312	316	Basal	9	Marshall	0	1	1	0	0	0	0		15.1	10.4		10.9	10.9		18.2		
313	317	Basal	9	Marshall	1	1	0	1	0	0	0		12.7	7.2		14.3	14.3		20.4		
314	318	Basal	9	Marshall	1	1	1	0	0	0	0		10.4	7.5		10.6	10.6	38.7	17.1	20.7	4
315	319	Basal	9	Marshall	1	1	1	0	0	0	0		9.7	9.2		10.1	10.1				11.9
316	320	Basal	9	Marshall	1	1	1	0	0	0	0		10.6	7.2		13.5	22.9		17.2	22.8	6.5
317	321	Basal	9	Marshall	1	1	1	0	0	1	0		7.7	6		12	12		18.5	21.8	
318	322	Basal	9	Marshall	1	1	1	0	0	1	0		6.1	6.1		11.3	11.3	24.9	16	17.8	5.9
319	323	Basal	9	Marshall	1	1	1	0	0	1	0		21.7	8.6		14.6	14.6	43.3	20.6	22.9	16
320	324	Basal	9	Marshall	0	1	1	0	0	1	0		14.5	7		13.5	13.5	40.5	17.2	18.4	13
321	325	Basal	9	Marshall	0	1	1	0	0	1	0		12.2	8.6		14	14		19.6	23	10.4
322	326	Basal	9	Marshall	1	1	0	0	0	0	0		5.4	4		11	11		15.5	17	
323	349	stem	17	Langtry	0	1	1	0	0	1	1	0.8	20.4	10	57.4	13.6	13.6	37.4	37.4	15.3	14.4
324	350	stem	17	Langtry	0	1	1	0	0	1	1	0.8	10.1	7.3	44.8	19.5	19.5	29.3	29.3	14.5	18
325	351	stem	17	Langtry	0	1	1	0	0	1	1	0.8	13.5	8	50.9	16.8	16.8	33.9	33.9	16.6	16.1
326	352	stem	17	Langtry	1	1	1	0	0	0	0		8.9	6.8	40.8	17.3	17.3	27.8	27.8	13.7	15.9
327	353	stem	17	Langtry	0	1	1	0	0	0	1		21.3	10.5	50.5	23.1	23.1	35.1	35.1	20.6	18.6
328	354	stem	17	Langtry	1	1	1	0	0	1	0		8.9	7.7		17.8	17.8	26.9	26.9	14.7	18
329	355	stem	17	Langtry	0	1	1	0	1	1	0		10.7	10		17.7	17.7	38.1	38.1	19.6	16.1

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
330	356	stem	17	Langtry	1	1	1	0	0	1	0		12.7	7.3		17	17	36.6	36.6	19.5	17.4
331	357	stem	17	Langtry	1	1	1	0	0	0	0		18.2	9.1		21.8	21.8	44.5	44.5	17.8	20.5
332	358	stem	17	Langtry	1	1	1	0	0	0	0		14.3	8.8		15.4	15.4	31.6	31.6	14.7	14
333	359	stem	17	Langtry	0	1	1	0	0	0	0		5	9.1		17.7	17.7			19	17.1
334	360	stem	17	Langtry	1	1	1	0	0	0	0		7.3	6.6		20.2	20.2	26.9	26.9	15.2	16.8
335	361	stem	17	Langtry	0	1	1	0	0	0	0		15.8	7.9		20.1	20.1	34.7	34.7	20.1	17.2
336	362	stem	17	Langtry	1	1	1	0	0	1	0		8.8	8		12.7	12.7	30.4	30.4	18.3	10.4
337	363	stem	17	Langtry	0	1	1	0	0	1	0		6.5	5.6		14.1	14.1	29.4	29.4	12.5	10.4
338	364	stem	17	Langtry	0	1	1	1	0	0	0		6.5	8.9		12.9	12.9	21.2	21.2	16.1	8.7
339	365	stem	17	Langtry	1	1	1	0	0	1	0		15.9	8.3		19.3	19.3	43.1	43.1	15.7	20.1
340	366	stem	17	Langtry	1	1	1	0	0	0	0		8.7	9.7		14.5	14.5	23	23	18.9	12.6
341	367	stem	17	Langtry	0	1	1	0	0	0	0		12.2	9.8		13.6	13.6	35.9	35.9	20.4	10.1
342	368	stem	17	Langtry	1	1	1	0	0	1	0		10	8.1		13.5	13.5	26.2	26.2	14	10.2
343	369	stem	17	Langtry	1	1	1	0	0	1	0		6.8	5.7		19	19	27.2	27.2	16	6.1
344	370	stem	17	Langtry	0	1	1	0	0	0	0		6.2	8.8		17.1	17.1	29.9	29.9	16	19.3
345	371	stem	17	Langtry	0	1	1	1	0	1	1	0.7	16.2	8.1	47.8	16.2	16.2	32.2	32.2	14.7	13.9
346	372	stem	17	Langtry	1	1	1	0	0	0	0		19.6	12.2		20.6	20.6	35	35	21	17.1
347	373	stem	17	Langtry	0	1	1	0	0	0	0		5.5	9.2		19.2	19.2			22.6	19.2

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
348	374	stem	17	Langtry	0	1	1	0	0	0	1		20.6	9.3	52.8	21.5	21.5	34.1	34.1	17.8	16.8
349	375	stem	17	Langtry	1	1	1	0	1	0	0		13.7	10		17.9	17.9	36.1	36.1	24	
350	376	stem	17	Langtry	0	1	1	0	0	1	1	1	8.1	8.6	45.5	6.9	6.9	19.8	19.8	11.1	7.8
351	377	stem	17	Langtry	1	1	1	1	0	1	0		15.7	8		18.4	18.4	34.6	34.6	17.2	19.3
352	378	stem	17	Langtry	1	1	1	0	0	1	0		20.6	9.2		22	22	35.4	35.4	19.3	22
353	379	stem	17	Langtry	0	1	1	0	0	1	1	0.6	19.5	10	46.8	13.8	13.8	38.5	38.5	23.1	11.4
354	380	stem	17	Langtry	1	1	1	0	0	1	0		11	9		16.6	16.6	42	42	18.8	11.5
355	381	stem	17	Langtry	0	1	1	0	0	1	1	0.7	15.2	8.7	44.7	14.3	14.3	31.3	31.3	15.4	13.1
356	382	stem	17	Langtry	0	1	1	0	0	1	1	0.9	6.1	7.6	24	13.7	13.7	24.1	24.1	21.4	12
357	383	stem	17	Langtry	0	1	1	0	0	1	1	0.8	9.6	8	41.8	16.5	16.5	26.7	26.7	11.1	12.8
358	384	stem	17	Langtry	1	1	1	0	0	1	0		8.9	6.4		16.4	16.4	33	33	17.6	14.8
359	385	stem	17	Langtry	1	1	1	0	0	0	1		42.4	12.4	73.7	18.7	18.7	39.6	39.6	13.3	18.4
360	386	stem	17	Langtry	1	1	1	0	0	1	0		17.1	10.3		15.8	15.8	34.9	34.9	20.5	14.1
361	387	stem	17	Langtry	1	1	1	0	0	1	0		14.5	7.6		20.3	20.3	34.2	34.2	15.9	18.3
362	388	stem	17	Langtry	1	1	1	0	0	1	0		16.3	9.3		16.4	16.4			15.2	17.2
363	389	stem	17	Langtry	0	1	1	0	0	0	1		24.9	10.7	56	15.4	15.4	33	33	25.5	14.6
364	390	stem	17	Langtry	1	1	1	0	0	1	0		6.7	6		16	16	26.3	26.3	11.6	13.7

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#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
365	391	stem	17	Langtry	1	1	1	1	0	1	0		13	7.6		18.3	18.3	26.8	26.8	13.8	21
366	392	stem	17	Langtry	0	1	1	0	0	1	1	0.8	17.9	8.7	54.9	18.6	18.6	31.8	31.8	14.2	17.2
367	393	stem	17	Langtry	1	1	1	0	0	1	1	0.7	13.3	7.4	47.5	16.5	16.5	36.9	36.9	13.6	14.4
368	394	stem	17	Langtry	1	1	1	0	0	1	0		7.3	7.5				31	31		
369	395	stem	17	Langtry	0	1	1	0	0	1	1	0.8	15.7	8	47	15.9	15.9	32	32	18.4	13.1
370	396	stem	17	Langtry	0	1	1	0	0	1	0		10.3	9.5	64			28.5	28.5		
371	397	stem	17	Langtry	0	1	1	1	0	1	1	0.9	5.3	6.7	25.1	11.1	11.1	25.1	25.1	18.6	8.8
372	398	stem	17	Langtry	0	1	1	0	0	1	1	0.8	13	9.3		18.5	18.5	33.1	33.1	14.3	24
373	399	stem	17	Langtry	1	1	1	0	0	0	0		18.4	10.6		14	14	32.3	32.3	15.9	11.2
374	400	stem	17	Langtry	1	1	1	0	0	0	0		14.3	9.2		16.1	16.1	39.9	39.9	15.5	15.4
375	401	stem	17	Langtry	1	1	1	1	0	1	0		12.9	9.1		20.8	20.8	38.1	38.1	15.9	22.5
376	402	stem	17	Langtry	0	1	1	0	0	0	1		13.8	7.8	47.2	16	16	31.7	31.7	17.6	14.8
377	403	stem	17	Langtry	0	1	1	0	0	1	1	0.9	7.7	6.5	33.3	15.6	15.6	25.5	25.5	16	12.2
378	404	stem	17	Langtry	0	1	1	1	0	1	1	0.8	11.2	8	46.7	14.1	14.1	29	29	15.3	13.9
379	405	side	12	Ensor	1	1	1	0	0	0	1		11.2	7.3		10.3	10.3	29.5	15.5		9.3

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
380	406	stem	16	Gary	0	1	1	0	0	1	1	0.9	10.5	7.4	34.8	15.7	15.7	32.3	32.3	13.6	14.5
381	414	stem	16	Gary	0	1	1	0	0	1	1	0.4	18.7	7.4	35.1	16.7	16.7	26.6	26.6	14.4	16.9
382	415	stem	16	Gary	0	1	1	0	0	1	1	0.6	10.1	7.6	37.2	20.2	20.2	25.8	25.8	14.6	16
383	416	stem	16	Gary	0	1	1	0	0	0	1		11	8.5	35.3	17.5	17.5	34.7	34.7	14.9	20.4
384	417	stem	16	Gary	0	1	1	0	0	1	0		8.8	7.1		13.3	13.3	27.7	27.7	16.2	10.3
385	418	stem	16	Gary	0	1	1	0	0	1	1	0.5	12.4	8.4	45.1	16.5	16.5	32	32	11.9	19.7
386	419	stem	16	Gary	0	1	1	0	0	1	1	0.8	6	7.2	35.1	14.6	14.6	21.9	21.9	12.3	12.6
387	420	stem	16	Gary	0	1	1	0	0	0	1		6.6	8.4	35.3	15.3	15.3	22.5	22.5	10	17.8
388	421	stem	16	Gary	0	1	1	0	0	0	1		12.8	9.4	31.1	30.7	30.7	29.5	29.5	12.4	27.3
389	422	stem	16	Gary	0	1	1	0	0	1	1	0.5	6	6.7	35.2	17.2	17.2	21.2	21.2	10.1	16.8
390	423	stem	16	Gary	0	1	1	0	0	0	0		15.8	9	47	18.3	18.3	33.3	33.3	15.9	15.4
391	424	stem	16	Gary	0	1	1	0	0	1	0		13.2	11		15.9	15.9	36.8	36.8	19.6	16.5
392	425	stem	16	Gary	0	1	1	0	0	1	1	0.6	12.6	8.5	48.9	17.6	17.6	31.6	31.6	14.5	18.2
393	426	stem	16	Gary	1	1	1	0	0	1	0		8.6	7		16.8	16.8	26	26	13.5	17.5
394	427	stem	16	Gary	0	1	1	0	0	0	1		10.5	11.2	35.3	16.4	16.4	29.1	29.1	14	14.7
395	428	stem	16	Gary	0	1	1	0	0	0	0		13.9	10.8		16.1	16.1	32.1	32.1	18.2	18.3
396	429	stem	16	Gary	1	1	1	1	0	1	1	1	13.5	8.5	41.6	16.8	16.8	32	32	18.9	15.6
397	430	stem	16	Gary	0	1	1	0	0	0	1		6.5	6.5	35.2	15.2	15.2	27.6	27.6	13.5	17.5

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#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
398	431	stem	16	Gary	0	1	1	0	0	1	1	0.9	5.5	7.3	25.2	14.1	14.1	19.4	19.4	10.3	13.8
399	432	stem	16	Gary	0	1	1	0	0	1	0		10.1	8.6		16.2	16.2	29.5	29.5	8.3	18
400	433	stem	16	Gary	1	1	1	0	0	0	0		7.5	8.6		14.9	14.9	33.7	33.7	7.9	15.1
401	434	stem	16	Gary	0	1	1	0	0	1	1	0.6	13.7	8	51.8	18.1	18.1	28.8	28.8	12.9	18.6
402	435	stem	16	Gary	0	1	1	0	0	0	1		26.8	13.8	59.3	20.2	20.2	33.2	33.2	15.3	21.4
403	436	stem	16	Gary	0	1	1	0	0	1	1	0.4	12.9	7.1	42.7	19.3	19.3	35	35	8.1	24.2
404	437	stem	16	Gary	1	1	1	0	0	0	0		7.4	7		14	14	23.8	23.8	11.3	14.5
405	438	stem	16	Gary	0	1	1	0	0	1	0		24.7	11.7	77.8			36	36		
406	439	stem	16	Gary	0	1	1	0	0	0	1		8.8	9.8	42.2	13	13	25.6	25.6	9.2	12.5
407	440	stem	16	Gary	0	1	1	1	0	1	1	0.5	8.9	7.9	35.4	19.8	19.8	27.1	27.1	13.5	19.5
408	441	stem	16	Gary	1	1	1	0	0	1	0		14.2	9.2		16.3	16.3				16.4
409	442	stem	16	Gary	0	1	1	0	0	0	1		13.5	11.4	35.8	17.4	17.4	30.6	30.6	9.8	24
410	443	stem	16	Gary	0	1	1	0	0	1	0		6.8	8.1	42.4	12.3	12.3			9.3	15.2
411	444	stem	16	Gary	1	1	1	0	0	0	0		10	10		16.5	16.5	30.9	30.9	14.5	15.1
412	445	stem	16	Gary	0	1	1	0	0	0	0		10.6	8.3		14.5	14.5	32.2	32.2	12.2	14.8
413	446	stem	16	Gary	0	1	1	0	0	0	1		21.1	11.7	55.9	15.3	15.3	25.4	25.4	10.2	16.4

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
414	447	stem	16	Gary	1	1	1	1	0	1	1	0.9	19.8	7		17.2	17.2	42.7	42.7	13.6	16.7
415	448	stem	16	Gary	0	1	1	0	0	1	1	0.8	19.9	8.5	53.3	22.4	22.4	35	35	16.9	21.6
416	449	stem	16	Gary	0	1	1	0	0	1	1	0.6	11.4	7.9	44.4	20.3	20.3	31.7	31.7	13.9	18
417	450	stem	16	Gary	1	1	1	0	0	0	0		17.3	1.4		11.2	11.2	29	29	11	15.2
418	451	stem	16	Gary	1	1	1	0	0	1	0		11.7	8.3	53.3	16.9	16.9			12	18.1
419	452	stem	16	Gary	1	1	1	0	0	0	0		13.4	8.1		19.9	19.9	46.4	46.4	22.5	19.8
420	453	stem	16	Gary	0	1	1	0	0	1	1	0.6	11.1	11.3	39.4	19	19	25.6	25.6	10.3	20.8
421	454	stem	16	Gary	0	1	1	1	0	0	1		17.6	8.6	58	18.8	18.8	34.4	34.4	13	18.9
422	455	stem	16	Gary	0	1	1	0	0	0	0		12.3	8.8	45.7			33.7	33.7		
423	456	stem	16	Gary	0	1	1	0	0	1	0	0.6	10.7	7.9	42.8	19.4	19.4			12.7	19.3
424	457	stem	16	Gary	0	1	1	0	0	0	1		18	12.5	51.7	16.3	16.3	30.7	30.7	10.8	16.9
425	458	stem	16	Gary	0	1	1	0	0	1	1	0.8	17.5	10.1	48.3	23.2	23.2	31.2	31.2	18.4	21
426	459	stem	16	Gary	0	1	1	0	0	0	1		4.8	7.7	25.7	6.7	6.7	20	20	7.2	9.2

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
427	460	stem	16	Gary	0	1	1	0	0	1	1	0.6	7.4	7.4	33.4	14.4	14.4	28.8	28.8	13.2	15.4
428	461	stem	16	Gary	0	1	1	0	0	1	1	0.7	8.5	8.2	37.4	19.2	19.2	21.2	21.2	8.7	22.6
429	462	stem	16	Gary	0	1	1	0	0	1	1	0.3	22.6	9	52.2	19.2	19.2	38.9	38.9	13.9	20.6
430	463	stem	16	Gary	0	1	1	0	0	0	1		7.4	8.4	34.8	15.8	15.8	19.7	19.7	11.3	14
431	464	stem	16	Gary	0	1	1	0	0	0	0		6.2	8.5		16.3	16.3	31.6	31.6	19.5	16.3
432	465	stem	16	Gary	0	1	1	0	0	1	1	0.6	12.4	7.7	55.5	17.7	17.7	29.3	29.3	13.2	16.6
433	466	stem	16	Gary	0	1	1	0	0	1	1	0.7	15.2	9	49.5	19.8	19.8	30.6	30.6	15.7	22.7
434	467	stem	16	Gary	0	1	1	0	0	1	1	0.7	7.6	9.9	39	14.1	14.1	21.9	21.9	14	14.7
435	468	stem	16	Gary	1	1	1	0	0	1	1	0.6	22.9	10.4	51.5	17.6	17.6	36	36	19	17.8
436	469	stem	16	Gary	1	1	1	0	0	1	0		8.7	6.4		16.6	16.6	31.6	31.6	10.2	21
437	470	stem	16	Gary	1	1	1	0	0	0	0		8.9	9.8		16.8	16.8	27.9	27.9	15	19
438	471	stem	16	Gary	0	1	1	0	0	1	1	0.8	3.6	7.3	28.5	10.1	10.1	21.8	21.8	8.5	9.9
439	472	stem	16	Gary	0	1	1	0	0	1	1	0.7	22.7	12.5	59.9	13.3	13.3	35.6	35.6	12.5	12.9
440	473	stem	16	Gary	0	1	1	0	0	0	1		13.8	8.3	40.9	15.4	15.4	36.1	36.1	17.2	12.4
441	474	stem	16	Gary	1	1	1	0	0	0	0		12.9	8.6		17.8	17.8	35.1	35.1	14.6	19.3
442	475	stem	16	Gary	0	1	1	0	0	0	1	0.4	7.9	7.5	29.6	17.7	17.7	27.3	27.3	10.7	15.9

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
443	476	stem	16	Gary	0	1	1	0	0	1	0		21.2	9.3		16.5	16.5	42.7	42.7	21.1	22.2
444	477	stem	16	Gary	0	1	1	0	0	0	1		11.6	9.8	37.8	19.8	19.8	26.7	26.7	15.4	20.9
445	478	stem	16	Gary	1	1	1	0	0	1	0		14.1	7.9				30.2	30.2	17.4	
446	479	stem	16	Gary	0	1	1	0	0	0	1		15.1	10.3	45.2	11.7	11.7	37.9	37.9	14.9	10.5
447	480	stem	16	Gary	1	1	1	0	0	0	1		5.8	9.2	31	15.8	15.8	19.2	19.2	9.6	14.8
448	481	stem	16	Gary	0	1	1	0	0	1	1	0.7	6.7	9	33.3	15.1	15.1	23.2	23.2	12.2	15.4
449	482	stem	16	Gary	0	1	1	0	0	0	1		13.6	9.1	49	19.1	19.1	32.9	32.9	13.9	20.9
450	483	stem	16	Gary	1	1	1	0	0	0	0		14	9.1		20.5	20.5	28.3	28.3	14.9	18.9
451	484	stem	16	Gary	0	1	1	1	0	1	0		14.1	8.2		13.8	13.8	45.4	45.4	22.5	15.2
452	485	stem	16	Gary	0	1	1	0	0	1	1	0.6	11.5	9.9	43.7	15.6	15.6	22.8	22.8	11	16.1
453	486	stem	16	Gary	1	1	1	0	0	1	1	0.8	10.9	9	44.6	18.2	18.2	30.7	30.7	11.2	16.6
454	487	stem	16	Gary	0	1	1	0	0	1	1	0.3	11.7	7.9	40.1	14.2	14.2	34.2	34.2	13.4	14.9
455	488	stem	16	Gary	0	1	1	0	0	1	1	0.8	12.1	5.5	47.2	17.3	17.3	33.8	33.8	14.9	17.2
456	489	stem	16	Gary	0	1	1	1	0	1	1	0.9	7.1	8.5	30.9	14	14	27.6	27.6	10.2	13.5
457	490	stem	16	Gary	0	1	1	0	0	1	1	0.7	7.4	7.3	36.4	19.5	19.5	24.5	24.5	12.9	18.4
458	491	stem	16	Gary	0	1	1	0	0	1	1	0.6	29.3	11.1	52.6	20.5	20.5	38.9	38.9	20.2	24.1
459	492	stem	16	Gary	0	1	1	0	0	1	1	0.8	15.6	9	47.8	22.2	22.2	30.7	30.7	16.2	22.4
460	493	stem	16	Gary	0	1	1	0	0	1	0		14.8	8.7		16.6	16.6	34.1	34.1	14	16.4

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to-Corner mm
461	494	stem	16	Gary	1	1	1	0	0	1	0		7.3	5.6		14.9	14.9	25	25	14.8	13.5
462	495	stem	16	Gary	0	1	1	0	0	0	1		10.4	8.2	38.3	19.4	19.4	28.6	28.6	12.5	17.8
463	496	stem	16	Gary	1	1	1	0	0	1	0		12.9	9.7		15.3	15.3	30.7	30.7	12.8	14.8
464	497	stem	16	Gary	0	1	1	0	0	1	1	0.5	54.5	10.2	91.2	17.5	17.5	48.5	48.5	21	16.9
465	498	stem	16	Gary	1	1	1	0	1	1	0		11	7.3		17.6	17.6	36.2	36.2	19.1	20.1
466	499	stem	16	Gary	1	1	1	1	0	1	0		5.9	5.8		17.1	17.1	22.4	22.4	12.1	14.6
467	500	stem	16	Gary	1	1	1	0	0	1	0		12.5	9	59.4	16.6	16.6			11.3	16.2
468	501	stem	16	Gary	0	1	1	0	0	1	1	0.6	12.1	7.3	45.2	16.3	16.3	29.6	29.6	16.3	15
469	502	stem	16	Gary	1	1	1	0	0	1	0	0.8	13.6	11		17.3	17.3	26.6	26.6	16	16.9
470	503	stem	16	Gary	0	1	1	0	0	1	0		8.4	7		19.4	19.4	27.6	27.6	30.7	19
471	504	stem	16	Gary	1	1	1	0	0	1	0	0.7	11.8	7.6	37.5	14.4	14.4	32.3	32.3	16.4	12.9
472	505	stem	16	Gary	0	1	1	1	0	1	0		11.3	6.3		16.2	16.2	36.9	36.9	15.7	22
473	506	stem	16	Gary	0	1	1	0	0	1	1	0.4	8	6.6	30.5	14.1	14.1	22.7	22.7	12.3	12.8
474	507	stem	16	Gary	1	1	1	0	0	0	0		8.7	7.6		13.6	13.6	34.3	34.3	12	15.3
475	508	stem	16	Gary	1	1	1	0	0	1	0		9.3	9.2		15.3	15.3	29.5	29.5	11.9	17.4
476	509	stem	16	Gary	1	1	1	0	0	0	0		11.3	11.6		13.2	13.2	22.2	22.2	12.5	12.9

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to-Corner mm
477	510	stem	16	Gary	0	1	1	0	0	0	0		9.7	9.2		17.6	17.6	34.4	34.4	20.2	17.6
478	511	stem	16	Gary	0	1	1	1	0	1	1	1	5.1	6	41.3	12.6	12.6	22.3	22.3	10	11.9
479	512	stem	16	Gary	1	1	1	0	0	0	0		6.8	7.6		18.4	18.4	29.4	29.4	11.8	18.9
480	513	stem	16	Gary	1	1	1	0	0	0	0		15.1	8.8		15.9	15.9	33.6	33.6	18.2	15.7
481	514	stem	16	Gary	0	1	1	0	0	1	1	0.9	18.6	9.6	42.2	18.2	18.2	33.8	33.8	18.6	16.7
482	515	stem	16	Gary	1	1	1	0	0	0	0		10.1	8.6		11.1	11.1	28.8	28.8	12.6	11.9
483	516	stem	16	Gary	1	1	1	0	0	1	0		24.7	9.8		22.2	22.2	40.9	40.9	19.5	22
484	517	stem	16	Gary	1	1	1	0	1	0	0		22.2	9.8		18.9	18.9	40.3	40.3	23.8	15.5
485	518	stem	16	Gary	0	1	1	0	0	0	1		8.2	8.1	41.7	16.4	16.4	25.4	25.4	10.9	14.7
486	519	stem	16	Gary	0	1	1	0	0	1	1	0.8	13.8	9.6	52.1	17.4	17.4	33.3	33.3	13.3	15.9
487	520	stem	16	Gary	1	1	1	0	0	0	0		16.7	10.7		20.8	20.8	30.9	30.9	15	20.7
488	521	stem	16	Gary	1	1	1	0	0	0	0	0.6	19.2	13.9		16.4	16.4	39.2	39.2	14.2	15.9
489	522	stem	16	Gary	0	1	1	0	0	1	1	0.5	12.8	9.8	49.8	16.8	16.8	28	28	12.7	12.9
490	523	stem	16	Gary	0	1	1	0	0	0	1		12.5	9.5	36.9	19.1	19.1	27.6	27.6	14.3	15.8
491	524	stem	16	Gary	1	1	1	0	0	1	0		14.2	7.5		19.6	19.6	37.7	37.7	16.6	19.8
492	525	stem	16	Gary	0	1	1	0	0	0	1		26.2	10.1	78.1	17.6	17.6	36.1	36.1	18.4	17.2
493	526	stem	16	Gary	1	1	1	0	0	1	0		24.7	9.4		15.8	15.8	42.8	42.8	21.3	18.1
494	528	stem	16	Gary	1	1	1	0	0	0	0		10	10.3		12	12	24.1	24.1	18.1	8.4

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#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
495	529	stem	16	Gary	1	1	1	0	0	0	0		12.3	7.8		16.8	16.8	31.5	31.5	18.1	16.6
496	530	stem	16	Gary	0	1	1	0	1	0	1		11.6	9	44.4	15.8	15.8	24.5	24.5	11.1	18.5
497	540	stem	16	Gary	0	1	1	0	0	0	1		9.9	9.3	37.8	18.3	18.3	32.9	32.9	13.5	20.4
498	541	stem	16	Gary	1	1	1	0	0	1	1	0.6	26.8	8.2	63.6	20.7	20.7	37.6	37.6	19.3	18.8
499	542	stem	16	Gary	1	1	1	0	0	0	0		19.9	9.2		20	20	35.3	35.3	16.6	18.8
500	542	stem	16	Gary	0	1	1	0	0	1	1	0.8	5.5	6.1	31.9	16.7	16.7	22.7	22.7	9.5	18.3
501	543	stem	16	Gary	0	1	1	1	0	1	1	0.8	11.3	9.9	34.6	14.3	14.3	35.3	35.3	14.9	13.9
502	544	stem	16	Gary	1	1	1	0	0	1	0		17.4	10.1		17.6	17.6	35.2	35.2	19.8	17
503	545	stem	16	Gary	0	1	1	0	0	0	1		10.8	8.8	40	20.5	20.5	30.7	30.7	19.6	19.9
504	546	stem	16	Gary	0	1	1	0	1	1	1	0.7	10.6	7.3	42.3	17.4	17.4	33.2	33.2	14.1	17.9
505	547	stem	16	Gary	0	1	1	0	0	0	0		20	16		16.5	16.5	35.5	35.5	15.8	16.4
506	548	stem	16	Gary	1	1	1	0	0	1	0		8.6	5.7		23	23			14.8	24.6
507	549	stem	16	Gary	0	2	0	0	0	0	1		8.2	7.8	40.3	13.1	13.1	27	27	14.8	13.4
508	550	stem	16	Gary	0	1	1	0	0	1	1	0.8	5.1	7.1	34.9	10.9	10.9	22.4	22.4	10.8	10.8
509	551	stem	16	Gary	1	1	1	0	0	1	1	0.7	7.5	7	34.1	14.1	14.1	27.4	27.4	14.2	12.2
510	552	stem	16	Gary	0	1	1	0	0	1	0		14.1	7.1		19.7	19.7	37.1	37.1	17.6	19.1

Appendix A: Tabulated Metric and Observational Data

#	Art No	Morp	Tp #	Type Name	Impt Fract.	Gen Matrll Type	Local Material/ Non-Local Material	Heat Treat	Cortx	Rew	Cond.	Indx of Inv.	Wt (g)	Max Thick mm	Bla Lth mm	Nck Ht. mm	Haft Lth. mm	Bla Wth. mm	Neck Wth. mm	Base Wth. mm	Shoulder -to- Corner mm
511	553	stem	16	Gary	0	1	1	0	0	1	1	0.8	8.2	8.4	35.3	19	19	31.6	31.6	13.3	18.6
512	554	stem	16	Gary	1	1	1	0	0	0	0		12.7	9.2		18.8	18.8	29.9	29.9	9.6	18.3
513	555	stem	16	Gary	1	1	1	0	0	1	1	0.8	7.2	5.9	30	15.3	15.3	27.5	27.5	14.1	14.7
514	556	stem	16	Gary	1	1	1	0	0	1	0		10.7	6.8	51	16.3	16.3			15.6	19.1
515	557	stem	16	Gary	0	1	1	1	0	0	0		21.1	11.7		11.4	11.4	32.4	32.4	16.2	10.4
516	558	stem	16	Gary	0	1	1	0	0	0	1		9.1	10.6	34.3	15.6	15.6	25.5	25.5	13.5	15.2
517	559	stem	16	Gary	0	1	1	0	0	1	1	0.6	27.2	12.4	59.9	18.7	18.7	27.6	27.6	16.7	16.1
518	560	stem	16	Gary	0	1	1	0	0	0	0		7	7.5		14	14	28.8	28.8	11.5	15.3
519	561	stem	16	Gary	1	1	1	0	0	0	0		6.8	10.6		12.5	12.5	31.2	31.2	15.8	12.5
520	562	stem	16	Gary	0	1	1	0	0	1	1		6.3	8.1	34.1	6.9	6.9	20.7	20.7	14.7	
521	563	stem	16	Gary	0	1	1	1	0	1	1	0.9	11.6	9		15.8	15.8	30.5	30.5	14.2	15.1
522	564	stem	16	Gary	0	1	1	0	0	1	1	0.6	8.6	8.4	40.1	14.8	14.8	28.5	28.5	9.3	18.2